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A NEW YELLOW NYMPHAEA FROM TROPICAL AFRICA[1]

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Nymphaea (§ Brachyceras) Burttii Pring & Woodson, spec. nov., foliis magnis longe-petiolatis orbiculare-sagittatis margine plus minusve conspicue undulato-sinuatis apice late obtusis vel rotundatis sinu profundo auriculis leviter divergentibus obtusis 25–35 cm. longis subcoriaceis utrinque viridibus vel saepius purpureo-maculatis glaberrimis vel umbilico paulo papillato subtus nervis manifestis sed vix prominentibus; floribus speciosissimis primulino-flavis 15–18 cm. diametro metientibus, sepalis ovato-lanceolatis acutiusculis 5–8 cm. longis 2–3 cm. latis dilute viridibus immaculatis laevibus, petalis ca. 20–23 anguste ellipticis apice acuminatis vel anguste acutis medio versus gradatim angustatis plerisque 5-nervatis exterioribus quam sepalis paulo brevioribus ca. 4.5–7.0 cm. longis 1.0–2.5 cm. latis, staminibus 190–200 linearibus connectivo manifeste elongato basi paulo ampliato exterioribus ca. 5 cm. longis dilute cadmio-flavis, carpellis 28–30 stylo linearo profunde inclinato stigmate concavo; fructu minore 3.5–4.0 cm. diametro metiente, seminibus ovoideo-oblongoideis apice minutissime apiculatis longitudine leviter puncticulato-striatis griseo-brunneis maximo ca. 0.075 cm. minimo ca. 0.05 cm. diametro metientibus.—Cult. Missouri Botanical Garden, Aug., 1930, *G. H. Pring s. n.* (Herb. Mo. Bot. Garden, TYPE).

Leaves large, long-petiolate, orbicular-sagittate, margin more or less conspicuously undulate-sinuate, apex broadly obtuse or rotund, sinus relatively deep and narrow, auricles obtuse, slightly

[1] Issued April 29, 1933.

divergent, 25–35 cm. long, subcoriaceous, either surface green, or occasionally somewhat purplish-maculate, particularly when young, glabrous, or the umbilicus slightly papillate, the nerves manifest but not prominent beneath; flowers showy, primrose-yellow, very fragrant, 15–18 cm. in diameter; sepals ovate-lanceolate, acute, 5–8 cm. long, 2–3 cm. broad, pale green, without purple spots, smooth; petals about 20–23, narrowly elliptic, apex

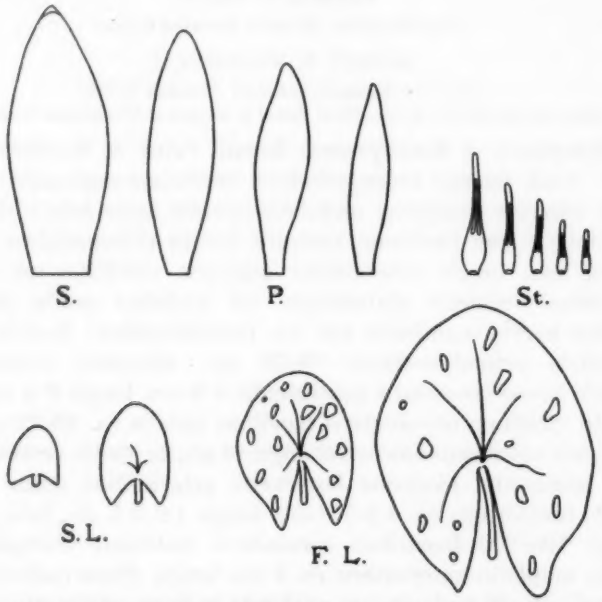

Fig. 1. *Nymphaea Burttii* Pring & Woodson: *S.*, sepals; *P.*, petals; *St.*, stamens; *S.L.*, submerged leaves; *F. L.*, floating leaves.

acuminate to narrowly acute, the base gradually narrowed from about the middle, 5-nerved, the exterior somewhat shorter than the sepals, usually 4.5–7.0 cm. long, 1.0–2.5 cm. broad; stamens 190–200, linear, the exterior about 5 cm. long, cadmium-yellow, the connective manifestly elongate, somewhat broadened at the base; carpels 28–30, the style linear, sharply inclined, the stigma concave; fruit relatively small, about 3.5–4.0 cm. in diameter; seeds ovoid-oblongoid, minutely apiculate, rather inconspicuously

puncticulate-striate longitudinally, about 0.075 cm. long, 0.05 cm. broad, grayish-brown.—Cultivated at the Missouri Botanical Garden, Aug., 1930, *G. H. Pring s. n.* (Herb. Mo. Bot. Garden, TYPE).

Only two yellow tropical Nymphaeas have previously been described from Africa: *N. sulphurea* Gilg and *N. Stuhlmannii* Schwfth. & Gilg. The former differs from *N. Burttii* chiefly in the smaller flowers (4–7 cm. in diam.) and leaves (4.5–5.5 cm. long), which are almost exactly orbicular-cordate in outline, purplish-maculate sepals, and more elongate tubers. *N. Stuhlmannii* is easily distinguishable from *N. Burttii* by the somewhat smaller flowers (10–15 cm. in diam.), with broader, obovate, obtuse or rounded petals, and smaller (21–25 cm. long), entire leaves, which are broadly ovate-cordate in outline, with broad, rounded, regular lobes. Furthermore, the venation of the leaves of *N. Stuhlmannii* is extremely verrucose beneath. The type specimen of *N. Stuhlmannii* has not been available to the writers for personal examination, but has been compared with a duplicate specimen of *N. Burttii* by Dr. H. Melchior, of the Botanical Museum at Berlin-Dahlem, who kindly affirmed the distinction of either species. A photograph of the type specimen of *N. Stuhlmannii* (*Stuhlmann 410* in Hb. Berol.), generously provided by Dr. L. Diels, Director of the Botanical Garden and Museum at Berlin-Dahlem, has been deposited in the herbarium of the Missouri Botanical Garden.

After a search of over ten years, the director of the Missouri Botanical Garden obtained in September, 1929, a seed-pod of what was presumed to be *Nymphaea Stuhlmannii* through the personal efforts of Mr. B. D. Burtt, Esq., botanist for the Tsetse Research Bureau, Kondoa, Tanganyika Territory. An excerpt from Mr. Burtt's notes is quoted.

> "The seed was collected from plants growing in a seasonal rain-pond in the Sambala 'Mbuga' seasonal swamp, the plants having spectacular yellow flowers 8 inches in diameter and sweet scented. The flowers float on the surface of the water and on examination were found to contain dead bees (*Apis melifera* [?]) that were imprisoned by the anthers over the stigmatic surface of the flowers. The plants were collected on May 19, 1929, the seed from the same locality on July 15, 1929. Other plants were collected March 16, 1929, from a seasonal rain pond near Salia, Kondoa Distr. I have observed the plant in seasonal rain ponds at Magungila, Wembare Steppe in 1928, also near Lilbilin, Massai Land, in 1927."

The single, small seed-pod, in somewhat immature condition, was received at the Garden on September 19, 1929. It was immediately cleaned, and the many seeds planted in the greenhouse water-lily tanks. Three weeks later a single seed germinated from the lot, producing its first primrose-yellow flower on June 17, 1930. On July 30, the plant was removed from its pot and planted in the pond out of doors where it continued to bloom until frost.

The successful introduction of a yellow tropical water-lily has opened an entirely new field for the hybridist. For many years the available colors in the Brachyceras group have been limited to blue and pink, and more recently to white through the introduction from the Missouri Botanical Garden of the hybrid "Mrs. G. H. Pring." During the past three seasons 250 pollinations have been made with the pollen of *N. Burttii*, resulting in many variable forms of commercial interest. The first season (1930) was devoted to selfing the yellow-flowered species, and many fertile seed-pods resulted. The following year twenty specimens were grown from seed and planted in the ponds out of doors. No variation in the color of the flowers was observed, but a variable character was evident in the peduncle and petioles, some being pure green, while about an equal number were brownish.

An unusual character, which appears to be dominant in all the plants, is a peculiar twisting of the peduncle, the day before the flower opens, in such a manner as to submerge the bud. The following morning, however, the peduncle straightens, holding the open flower erect in a natural position. This action has also been observed in several hybrids.

As a propagator, *Nymphaea Burttii* is by far the poorest of any grown at the Garden. Of the fifty propagating tubers secured from pot plants during the past two seasons, only one has produced growth up to the present, despite the fact that they have been in the heated propagating tanks for a period of six months. Since it is an extremely poor propagator from tubers and extreme heat is necessary for growth, it is very doubtful if it will find a place in garden pools. On the other hand, the hybrids derived from it, particularly the "Saint Louis," are both readily propagated from tubers and suitable for cooler water.

Explanation of Plate

PLATE 1

Leaf, bud, and flower of *Nymphaea Burttii* Pring & Woodson, × 3/5.

del. A. A. Heinze

PRING & WOODSON—A NEW YELLOW NYMPHAEA

CONTRIBUTION TO THE LICHEN FLORA OF NORTH AMERICA[1]

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The lichens here described have been collected in the northern section of North America. Of these specimens, 18 are Alaskan, 60 from eastern Canada (New Brunswick, except one from Quebec), approximately 150 from western Canada (British Columbia and Alberta), and a few from the state of Wyoming.

The Alaskan lichens, 15 species in all, are largely the usual arctic ground lichens. The New Brunswick lichens, which comprise 46 species, come from around Dalhousie and were collected in the year 1930 by the agronomist Tapio Reijonen. *Usnea longissima* was collected near Franklin, Quebec, by Dr. Viljo Kujala in 1931 during his scientific journey. On this same journey, he collected in western Canada (120 species, varieties, and forms) and in Wyoming (6 species). The latter specimens come from the sandstone in a cactus desert.

The lichens from western Canada were collected by Dr. Viljo Kujala in various types of forest in British Columbia in the following localities: Jackman, Longworth, Aleza Lake, Prince George, Six Mile Lake (Trout Lake), Hazleton, Dorreen, Cowichan Lake (Vancouver Island), Kamloops, Fish Lake (near Kamloops), Blue River, Valemount, Golden, Field, and in Alberta in the vicinity of Lake Louise. The desert lichens come principally from the vicinity of Kamloops in British Columbia and from Wainwright in Alberta.

Although the same species have been encountered in several different localities, the total number of species, varieties, and forms is 171 with 5 entirely new species, as follows: *Usnea Kujalae*, *Placodium xanthostigmoideum*, *Nephromium canadense*, *Diploschistes canadensis*, and *Sphaerophorus Tuckermanii*.

The list further includes eleven new varieties and forms, as follows: *Usnea comosa* var. *stuppea*, *Alectoria sarmentosa* var. *gigantea*, *A. Fremontii* f. *perfertilis*, *Cetraria nigricans* var. *pallida*,

[1] Duplicates of most of the specimens have been deposited in the herbarium of the Missouri Botanical Garden.

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C. tenuifolia var. *reticulata*, *C. tenuifolia* var. *pseudoislandica* f. *septentrionalis*, *C. juniperina* var. *canadensis*, *C. juniperina* var. *crispata*, *Parmelia elegantula* var. *americana*, *Cyanisticta Hookeri* var. *septentrionalis*, *Mycoblastus sanguinarius* var. *Dodgeanus*.

Species new to North America or otherwise noteworthy include the following: *Usnea lapponica*, *U. dasypoga*, *U. caucasica*, *U. prostrata*, *U. rugulosa*, *U. similis*, *Alectoria Fremontii* subsp. *olivacea*, *A. jubata* var. *Vrangiana*, *Ramalina Roesleri*, *Ochrolechia upsaliensis*, *Pertusaria xanthostoma*, *Physcia pyrithrocardia*, *P. muscigena* f. *squarrosa*, *P. endophoenicea*, *Peltigera Maurizii*, *P. canina* var. *suomensis*, *P. lepidophora*, *P. Nylanderi*, *Cetraria Merrillii*, *Parmelia Delavayi*, *Squamaria alphoplaca*, *Nephromium subparile*, *Lobaria oregana*, *Diploschistes bryophiloides*.

The lichens collected by Dr. Kujala are principally epiphytic and soil-lichens from a variety of forest types, although a few of the soil lichens come from fields or desert. It might be interesting to note here that in regions as widely separated and isolated as the North American prairies and the south Russian and Asiatic steppes and deserts there appear many identical, or, at least similar, lichen forms living on the ground. Such steppe lichens are: *Parmelia vagans* (appearing also in south Russia and Asia), *Physcia muscigena* (many forms, a few also growing in the mountains), *Acarospora Schleicheri* (appears in the Asiatic, North-African, and Russian steppes, in addition to the European Alps and Pyrenees),[1] *Psora decipiens* (also in deserts and mountains), *Diploschistes canadensis* (the similar Russian *D. scruposus* var. *terrestris*), *Ochrolechia upsaliensis* (sporadically found outside of the steppes), *Cladonia cariosa* var. *cribrosa* (particularly on other mineral substrates, slightly calciphile).

As the lichens in this collection were not collected by a lichenologist, the lichen flora of the various localities is very poorly represented and poor in species. They are, however, of particular interest to the European investigator on account of the many similar forms. The typical European *Cetraria juniperina* and *C. islandica* do not appear at all amongst the American lichen specimens (the latter also being absent from the "*Cetraria islandica*" specimens collected in Tierra del Fuego by Professor Auer's expedition in 1929).

[1] Magnusson, Monogr. Acarospora. p. 395, 1929.

As the lichens from the various localities have not been sufficiently collected, conclusions as to the relationship between the American and European species are still hypothetical, particularly as the present systematic revision of lichens necessitates many corrections of the earlier determinations. We can, however, state that as far as our present knowledge extends a great number of identical lichen forms appear both in North America and Eurasia, although the quantitative relationships between the different species differ considerably on the two sides of the Atlantic.

I wish to acknowledge with thanks Dr. C. W. Dodge, Mycologist to the Missouri Botanical Garden, who has kindly translated my manuscript from German to English, and T. Hidén, of Helsinki, Finnland, who has gone over the latin text of this work.

USNEA DASYPOGA (Ach.) Röhl. New Brunswick: Dalhousie; British Columbia: Prince George and Six Mile Lake, on *Picea*. Sterile.

USNEA DASYPOGA var. SUBSCABRATA Vain. British Columbia: Hazleton, on *Betula* and *Pinus*. Sterile.

USNEA CAUCASICA Vain. Thallus prostratus, glauco-viridis, medulla sublaxa, K−.—British Columbia: Six Mile Lake, on *Picea*. Fertile.

USNEA PROSTRATA (Vain.) Räs. British Columbia: Aleza Lake, on *Picea*. Sterile.

USNEA RUGULOSA Vain. British Columbia: Hazleton, on trunks of *Pinus Murrayana*. Sterile.

USNEA LONGISSIMA Ach. Quebec: north shore of the St. Lawrence Bay, Franklin, especially on branches of *Picea* in a mixed forest; British Columbia: Vancouver, Catillano Canyon, on *Thuja* in a forest with abundant ferns. Sterile.

USNEA COMOSA (Ach.) Vain. Thallus erectus, parce sorediosus, soredia isidiosa; medulla crebra, K−.—New Brunswick: Dalhousie, on *Picea;* British Columbia: Hazleton, rarely on branches of *Pinus Murrayana*. Sterile.

USNEA COMOSA var. **stuppea** Räs., var. nov. Thallus erectus aut suberectus, brevior fruticulosus, 5–7 cm. longus, laevigatus vel leviter verrucosus, sorediosus, pallido-stramineus; soredia maculiformia, demum parce isidiosa. Medulla laxa, stuppea, K−.—British Columbia: Hazleton, very frequent on small, half-dried *Pinus*, *Picea*, and *Betula*, on a sandy heath. Sterile.

USNEA SIMILIS Motyka

U. subcomosa Vain. in Kgl. Danske Vidensk. Selsk. Skrifter, Nat. og Math. Afd. VIII. **6**: 392 (110). 1924.

With the above species, occasional in Hazleton. Sterile.

USNEA LAPPONICA Vain. With the above species, Hazleton, on *Pinus*. Sterile.

USNEA HIRTA (L.) Motyka. British Columbia: Aleza Lake, occasional on *Picea canadensis* and *P. Engelmannii*. Sterile.

USNEA **Kujalae**[1] Räs., sp. nov. Thallus curtus, erectus, fruticulosus, 3–5 cm. longus, bene ramosus, lacteo-stramineus vel albo-viridis, sorediosus. Rami laevigati, sine verruculis nervisque. Medulla laxissima, K−. Apothecia rara, terminalia, 2–3 mm. lata, albido-straminea, fibrillosa, plana. Sporae 9–10 × 5.3–7 μ, ovoideo-

[1] In honor of Dr. Viljo Kujala.

ellipsoideae, 8 : nae, monostichae. Asci cylindrici. Hymenium 80 μ crassum, I+, caerulescens. Subsimilis *Usneae sorediiferae* Motyka, sed thallus albidus et parce sorediosus.—British Columbia: Hazleton, abundant on branches of *Pinus Murrayana*. Rarely fertile.

Alectoria sarmentosa Ach. Thallus elongatus, pendulus vel prostratus, K = K(Cl) ∓ leviter roseus, demum ferrugineus, I ∓ leviter caerulescens. Sporae normaliter binae vel 4:nae, fuscae.—British Columbia: Aleza Lake, frequent on branches of *Abies lasiocarpa*, *Picea canadensis*, and *P. Engelmannii;* Longworth, frequent on branches of *Thuja;* Hazleton, rarely on *Pinus*. Fertile.

Alectoria sarmentosa var. **gigantea** Räs., var. nov. Thallus elongatus, pendulus vel prostratus, 50–80 cm. longus, albido-stramineus, parce pseudocyphellatus, esorediatus, K=, K(Cl) =, Cl =, I= leviter caerulescens. Apothecia vulgaria, plana vel concava, atro-fusca vel livido-fusca, nuda vel leviter pruinosa. Sporae normaliter 3:nae, 25–31 × 14.5–20 μ, ellipsoideae, fusco-nigrae. Hymenium 130 μ crassum, I+ caerulescens.—British Columbia: Longworth, frequent on *Thuja;* Dorreen, on *Pseudotsuga*.

Alectoria laeta (Tayl.) Linds.

A. japonica Tuck., *A. osteina* Nyl., *A. lata* DR. (Arkiv f. Bot. 20[11]: 24. 1926).

Thallus suberectus vel prostratus, osteo-ochroleucus, apicem versus concolor, K± passim obsolete intensive fulvescens, K(Cl) ∓ roseus.—British Columbia: Hazleton, occasional on the ground; Alaska, occasional on the ground. Sterile.

Alectoria ochroleuca (Ehrh.) Nyl. Thallus pro parte ochroleucus, majore parte viridi-niger, K = vel basim versus obsolete ± dilute fulvescens, K(Cl) =.—Alaska, on the ground. Sterile.

Alectoria implexa (Hoffm.) Nyl. f. fuscidula Arn. Thallus pallido-fuscescens, K± lutescens, sorediosus. Soredia albida.—British Columbia: Hazleton, on branches of *Pinus*, Aleza Lake, on branches of *Abies* and *Picea*. Sterile.

Alectoria jubata (L.) Nyl. var. prolixa Ach. Thallus fuscescens vel nigro-fuscescens, K =, sorediosus. Soredia copiosa, albida.—New Brunswick: Dalhousie, on trunks of *Abies;* British Columbia: Kamloops, Fish Lake, Golden, and Aleza Lake, very frequent on branches and trunks of *Pseudotsuga* and *Pinus Murrayana*. Also on conifers near Hazleton. Sterile.

Alectoria jubata var. Vrangiana (Gyeln.) Räs.

A. Vrangiana Gyeln. (Magyar Bot. Lap. **31**: 46. 1932).

Thallus parce sorediosus, vel fere esorediatus, olivaceo-viridis vel fusco-viridis, K =, K(Cl) =.—British Columbia: Hazleton, on conifers, occasional. Sterile.

Alectoria Fremontii Tuck. f. **perfertilis** Räs., forma nov. Thallus prostratus, obscuro-castaneo-fuscus, laevis, subnitidus, esorediatus, K =, Cl =, K(Cl) =. Apothecia vulgaria numerosissima, lateralia, convexa, flavida. Sporae 5–8 × 5 μ, ovoideae, 8 : nae, hyalinae. Hymenium I+ caerulescens.—British Columbia: Golden, on the trunks and branches of *Pinus Murrayana*.

Alectoria Fremontii subsp. olivacea Räs. Thallus olivaceo-castaneus, prostratus, laevis, nitidus, esorediatus, K =, Cl =, K(Cl) =. Apothecia rarissima, minora, flavida.—British Columbia: Golden, on *Pinus Murrayana* and *Pseudotsuga*, Kamloops, Fish Lake, on *Pinus Murrayana*. Sterile.

The sorediose form, named by Du Rietz (Arkiv f. Bot. 20[11]: 8. 1926) subsp. *Eriksonii*, was not seen among the North American specimens. It would appear more correct, as Du Rietz (*l. c.*) thinks, not to regard the sorediose form as the main species. My subspecies *olivacea* (Räsänen, Medd. Soc. Fauna Flora Fennica **43**: 4.

1916) is much shinier than the North American type and has very rare apothecia, so that we have here three different *Alectoria* types.

RAMALINA THRAUSTA (Ach.) Nyl. British Columbia: Hazleton, on branches of conifers, Prince George and Six Mile Lake, on *Picea*. Sterile.

RAMALINA GENICULATA Nyl. British Columbia: Hazleton, on branches of *Pinus Murrayana*, rare. Sterile.

RAMALINA ROESLERI (Hochst.) Nyl. New Brunswick: Dalhousie, on branches of *Picea*, *Sorbus*, and on a wooden wall. Sterile.

RAMALINA CALICARIS (L.) Fr. New Brunswick: Dalhousie, on trunks of *Populus*. Fertile.

LETHARIA VULPINA (L.) Vain. Thallus sorediosus. Medulla I+ caerulescens.—British Columbia: Kamloops, Fish Lake, and Field (subalpine), on branches and trunks of *Pseudotsuga*. Sterile.

LETHARIA VULPINA f. INCOMPTA Ach. Thallus sorediosus et bene isidiosus, medulla I+ caerulescens.—Found with the species near Fish Lake, Golden, and Jackman, B. C., on *Pinus Murrayana*. Sterile.

CORNICULARIA DIVERGENS Ach. Alaska (alpine), on the ground. Sterile.

CETRARIA MERRILLII DR.

C. californica var. *Tuckermanii* Howe

Thallus 0.5–2 cm. longus, rigidus, erectus, divaricato-ramosus, opacus, olivaceo-niger. Rami angulato-nervosi, foveolati. Apothecia vulgaria, 0.5–3 mm. lata, plana vel convexa, terminalia, atra vel fusco-nigra, nuda, subnitida, subciliata. Sporae 8:nae, 6–8 × 4–5.5 μ, ovoideae, incoloratae.—British Columbia: Golden, Kamloops, Fish Lake, and Hazleton, on branches of *Pinus Murrayana* and other conifers. Fertile.

CETRARIA NIGRICANS Nyl. var. **pallida** Räs., var. nov. Thallus superne pallidus vel olivaceo-pallidus, subtus albidus, basim versus sanguineo-lentus; medulla I+ caerulescens. Laciniae 1–2 mm. latae, subcanaliculatae, denticulato-ciliatae, dichotome ramosae.—Alaska, on the ground with *Alectoria ochroleuca* and *Cornicularia divergens*. Sterile.

CETRARIA TENUIFOLIA (L.) Vain. Thallus canaliculatus, laevigatus, medulla K−.—Alaska, rarely with the previous species. Sterile.

CETRARIA TENUIFOLIA var. **reticulata** Räs., var. nov. Thallus subtus foveato-reticulatus, castaneo-fuscus, in marginibus dense isidioso-dentatus. Laciniae angustae, canaliculato-tubulosae, crispatae, marginem versus pseudocyphellatae. Medulla K−.—British Columbia: Kamloops, on stones, Valemount and Aleza Lake, on the ground. Sterile.

CETRARIA TENUIFOLIA var. PSEUDOISLANDICA Räs. (Ann. Bot. Soc. Zool.-bot. Fenn. Vanamo **2**: 15. 1932) f. **septentrionalis** Räs., forma nov. Medulla I−. Thallus similis *C. islandicae*, sed I−, et margo laciniarum fere sine spinis vel ciliis. Color pallido-castaneus.—British Columbia: Golden, on trunks and branches of dwarf shrubs near the ground. Sterile.

The true *Cetraria islandica* (L.) Ach., which gives the reaction "Medulla I lutescens, demum ferrugineo-rubescens," has not been seen by me from either North or South America.

CETRARIA NIVALIS (L.) Ach. British Columbia: Kamloops, on the ground and rocks in semi-desert; Alaska, on the ground. Sterile.

CETRARIA CUCULLATA (Bell.) Ach. British Columbia: Valemount, on the ground with *Arctostaphylos Uva-ursi;* Alaska (alpine), on the ground. Sterile.

CETRARIA CAPERATA (L.) Vain.

C. pinastri (Scop.) Röhl.

British Columbia: Hazleton, a small specimen with other *Cetraria* species on branches of *Pinus Murrayana*, Aleza Lake, a chiefly geoplese lichen (Räsänen, Über Flechtenstand u. Fl. Veget. im Westl. Nordfinnl., p. 84. 1927), with *Parmelia ambigua* and *P. pallescens* on the base of *Abies lasiocarpa*. Sterile.

CETRARIA JUNIPERINA (L.) Fr. var. VIRIDIS (Schweinitz) Räs.

C. viridis Schweinitz apud Halsey, Ann. Lyceum Nat. Hist. New York 1: 16. 1824; *C. juniperina* var. *virescens* Tuck.

Thallus curtus, rigidus; laciniae obtusae, obscuro-virides; K=, Cl=, I=. Apothecia terminalia, majora, 3–8 mm. lata, fusco-nigra, subnitida, margo subcrenata, tenuis. Sporae 8 : nae, ovoideae, 6–8 × 3.5–6.5 μ, incoloratae.—British Columbia: Golden, common on branches of *Pinus Murrayana*. Fertile.

CETRARIA JUNIPERINA var. **canadensis** Räs., var. nov. Thallus erectus vel suberectus, subrigidus; laciniae obtusae, aureo-flavae vel interdum viridi-flavae, super reticulato-nervosae, intus flavae. Apothecia terminalia, minora, 1–3 mm. lata, castaneo-fusca, nitida; margo lacerato-crenata. Sporae 6.5–8 × 4–5.2 μ, ovoideae, 8:nae, hyalinae.—British Columbia: Kamloops, Fish Lake, Aleza Lake, and Hazleton, very frequent on twigs of conifers.

C. juniperina (the main species) has apothecia chiefly in the middle of the thallus and the lobes are very divided. Also, the color of this species is not so bright a golden yellow as in the variety *canadensis*, and the surface is furthermore much smoother in the species.

CETRARIA JUNIPERINA var. **crispata** Räs., var. nov. Sicut var. *canadensis*, sed thallus dense lacerato-crispatus vel subpapillatus. Apothecia rara. Est analogica cum *C. juniperina* var. *terrestris* Schaer. (= *C. Tilesii* Ach. in Zahlbr. Cat. Lich. Univ. 6: 341. 1930).—British Columbia: Golden, rarely on branches of *Pinus Murrayana* with var. *viridis*. Fertile.

CETRARIA ALEURITES (Ach.) Th. Fr. New Brunswick: Dalhousie, on trunks of *Abies* and on wood. Sterile.

CETRARIA CHRYSANTHA Tuck.

Platysma septentrionale Nyl.

Thallus stramineus, lacunoso-nervosus, esorediatus, subtus fusco-niger, K± lutescens, Cl=, K(Cl)∓ roseus, I=.—Alaska (alpine), on the ground. Sterile.

CETRARIA LACUNOSA Ach. var. MACOUNII DR. Thallus subtus fusco-niger, non isidiosus, I=.—British Columbia: Kamloops, on stones in semi desert. Sterile.

CETRARIA NORVEGICA (Lynge) DR. Thallus isidiosus, I=.—With the above species in Kamloops, on stones. Sterile.

CETRARIA GLAUCA (L.) Ach. Thallus I∓ caerulescens.—With the above species in Kamloops, on stones; Prince George, Six Mile Lake, abundant on *Picea;* Aleza Lake and Vancouver, on branches of *Picea*. Sterile.

CETRARIA GLAUCA var. STENOPHYLLA Tuck. (Syn. North Amer. Lich. 1: 36. 1882). Thallus I∓ caerulescens, anguste laciniatus, glaucus, subtus niger.—British Columbia: Vancouver Is., Lake Cowichan, occasional on the lower branches of *Picea* in the forest. Sterile.

CETRARIA SCUTATA (Wulf.) Poetsch

C. chlorophylla (Willd.) Dalla Torre et Sarnth

British Columbia: Kamloops, Fish Lake, Golden, Hazleton, Aleza Lake, on the branches of *Pinus Murrayana* and *Abies;* Vancouver Is., Lake Cowichan, occasional on *Thuja gigantea*. Sterile.

NEPHROMOPSIS PLATYPHYLLA (Tuck.) Herre

Cetraria platyphylla Tuck.

Thallus 1–3 cm. latus, irregulariter laciniatus, super opacus, obscure fuscus, tuberculosus, subtus pallide fuscus, reticulato-nervosus. Apothecia marginalia, minora, 1–2 mm. lata, plana, fusca, tenuiter marginata; margo crenata. Sporae sphaeroideae vel subellipsoideae, 8:nae, incoloratae, 4–6.5 μ. Hymenium ca. 50 μ crassum, I+ caerulescens.—British Columbia: Golden, on twigs of *Pinus Murrayana*.

NEPHROMOPSIS CILIARIS (Ach.) Hue. British Columbia: Aleza Lake, a small specimen on *Pinus Murrayana*. Sterile.

PARMELIA PALLESCENS (Neck.) Räs.

P. hyperopta Ach.

New Brunswick: Dalhousie, on trunk of *Abies;* British Columbia: Aleza Lake, on base of *Abies lasiocarpa* as a geoplese lichen. Sterile.

PARMELIA AMBIGUA (Wulf.) Ach. New Brunswick: Dalhousie, on wood; British Columbia: Aleza Lake, on base of *Abies lasiocarpa* and *Pinus Murrayana*. Sterile.

PARMELIA PHYSODES (L.) Ach. f. LABROSA Ach. New Brunswick: Dalhousie, on trunk of *Abies;* British Columbia: Aleza Lake, on trunks of *Picea*, Kamloops, on *Pinus Murrayana*. Sterile.

PARMELIA PHYSODES f. VITTATA Mereshk. British Columbia: Aleza Lake and Hazleton, on branches of *Pinus Murrayana*. Sterile.

PARMELIA LOPHYREA Ach. Thallus cinereus, esorediatus, K± lutescens, K(Cl) ∓ roseus. Apothecia vulgaria, subtus ampullacea, demum ca. 5 mm. lata. Sporae sphaeroideae, 2.5–5 μ, 8 : nae, incoloratae. Hymenium 50 μ crassum, I+ caerulescens.—British Columbia: Golden, on branches of *Pinus Murrayana;* Aleza Lake, on branches of *Picea*.

PARMELIA DELAVAYI (Hue) Nyl. Thallus parvus, esorediatus, obscure cinereus. Apothecia vulgaria, demum 5 mm. lata, subtus non ampullacea, discus fuscus, urceolatus vel deplanatus. Sporae 5–7 × 4–5 μ, 8 : nae, ovoideae. Hymenium ca. 55 μ crassum, I+ caerulescens.—British Columbia: Golden, on *Pinus Murrayana*.

PARMELIA ENTEROMORPHA Ach. Thallus esorediatus, ventricoso-inflatus, cavus, K± lutescens, K(Cl) = .—British Columbia: Vancouver Is., Lake Cowichan, on trunk of *Thuja gigantea*. Sterile.

PARMELIA VITTATA (Ach.) Röhl. British Columbia: Prince George, Six Mile Lake, on trunk of *Betula*?. Sterile.

PARMELIA SULCATA Tayl. New Brunswick: Dalhousie, on trunks of *Betula, Sorbus, Picea, Abies,* and on wood; British Columbia: Prince George, Six Mile Lake, on *Betula;* Hazleton, on *Betula;* Golden, on *Pinus Murrayana* and *Pseudotsuga;* Kamloops on arid ground. Sterile.

PARMELIA VAGANS Nyl.

P. molliuscula Tuck. (Syn. North Amer. Lich. 1: 64. 1882).

Thallus dichotome laciniatus, sine sorediis et isidiis, stramineo-virens, K ∓ fulvescens.—British Columbia: Kamloops, on the ground between grasses and shrubs. Sterile. The lichen is a typical desert lichen and appears also in such environment in Russia and Asia.

PARMELIA SUBAURIFERA Nyl. New Brunswick: Dalhousie, on the trunk of *Sorbus;* British Columbia: Hazleton, on the trunk of a *Populus*. Sterile.

PARMELIA PAPULOSA (Schaer.) Vain.

P. exasperatula Nyl.

New Brunswick: Dalhousie, on the trunk of *Sorbus*. Sterile.

PARMELIA ELEGANTULA (Zahlbr.) Räs. var. **americana** Räs., var. nov. Thallus opacus, obscure olivaceo-fuscescens, isidiosus, K=, Cl=, K(Cl)=. Isidia subcylindrica, curta, concoloria. Apothecia desunt.—British Columbia: Kamloops, on a *Pseudotsuga* in semi-desert.

PARMELIA PUBESCENS (L.) Vain. var. RETICULATA Cromb. British Columbia: Kamloops, on a stone in semi-desert. Sterile.

THAMNOLIA VERMICULARIS (Sw.) Schaer. Alaska (regio alpina), on the ground between tufts of *Cornicularia divergens* and *Cladonia rangiferina*. Sterile.

SIPHULA CERATITES (Wahlbg.) Fr. British Columbia: Dorreen, on stones in moist mountain forest. Sterile.

STEREOCAULON TOMENTOSUM Fr. British Columbia: Dorreen, on branches of *Tsuga;* Alberta: Lake Louise, on mossy earth; Alaska (regio alpina), between *Cornicularia divergens* and *Cetraria chrysantha*. Rarely fertile.

LECANIA DIMERA (Nyl.) Th. Fr. British Columbia: Aleza Lake, very common on the trunks of *Populus*. Fertile.

SQUAMARIA ALPHOPLACA (Wahlbg.) Dub. Thallus orbicularis, radiatus, griseus, K+ partim rubescens. Medulla I−. Apothecia ca. 1 mm. lata, nigra, nuda vel tenuiter pruinosa. Sporae 9, 6.5 μ, 8 : nae.—U. S. A.: Cody, Wyoming, on sandstone in a cactus desert.

ASPICILIA CALCAREA (L.) Mudd. With the previous on sandstone in cactus desert, in Cody. Fertile.

LECANORA COILOCARPA (Ach.) Nyl. New Brunswick: Dalhousie, on a rail fence. Fertile.

LECANORA UMBRINA (Ehrh.) Röhl. New Brunswick: Dalhousie, on a stone in a field. Fertile.

LECANORA SYMMICTA Ach. Thallus areolato-verruculosus, mox totus sorediosus, virescens, K−, Cl+ aurantiaco-rubescens. Apothecia livida, mox convexa, fere immarginata.—New Brunswick: Dalhousie, on a wood rail fence.

I have found the same lichen—not in any way to be confused with *Biatora symmictera* (Nyl.) Räs.—in the summer of 1931, on a wooden fence in Petsamo, Finnland. Except for this I have not seen this central European and North American species.

LECANORA SUBINTRICATA Nyl. British Columbia: Kamloops, Fish Lake, on trunks and branches of *Pinus Murrayana*. Fertile.

OCHROLECHIA UPSALIENSIS (L.) Mass. Thallus K−, Cl−, K(Cl)−. Epithecium K(Cl)−. Apothecia 1–2 mm. lata, planiuscula vel urceolata, pruinosa. Margo crassa, subrugosa.—British Columbia: on rotting vegetable remains in somewhat shaded positions in the semi-desert.

PHLYCTIS ARGENA (Ach.) Flot. New Brunswick: Dalhousie, on trunk of *Abies* sp. Sterile.

PERTUSARIA PERTUSA (L.) Tuck. New Brunswick: Dalhousie, together with previous species on *Abies*. Fertile.

PERTUSARIA XANTHOSTOMA (Smrft.) Fr. Thallus verruculoso-inaequalis, K−, K(Cl)−. Apothecia 0.5 mm. lata, punctiformia, pallido-lutescentia. Excipulum K+, sanguineo-rubescens. Sporae 4: nae, ellipsoideae, incoloratae, 58–66 × 26–40 μ. Hymenium I+ caerulescens.—New Brunswick: Dalhousie, on a *Thuja* trunk.

PERTUSARIA MULTIPUNCTA (Turn.) Nyl. British Columbia: Aleza Lake, on the trunk of an *Abies*. Fertile.

PERTUSARIA FAGINEA (L.) Vain.

P. amara (Ach.) Nyl.

Thallus albidus, partim albo-sorediosus, K+ demum rubescens, K(Cl)+ mox violascens.—With the previous species on an *Abies* at Aleza Lake. Sterile.

XANTHORIA POLYCARPA (Hoffm.) Flag. New Brunswick: Dalhousie, on a *Sorbus* and a rail fence. Fertile.

PLACODIUM ELEGANS (Link) DC. New Brunswick: Dalhousie, on a field stone. Fertile.

PLACODIUM FERRUGINEUM (Huds.) Rabenh. New Brunswick: Dalhousie, on the fibrous trunks of a *Thuja*. Fertile.

PLACODIUM **xanthostigmoideum** Räs., n. sp. Thallus totus leproso-granulosus, citrinus vel aurantiaco-citrinus, K+ violascens. Similis *Candelariellae xanthostigmae* (Pers.) Lettau, sed thallus K+.—New Brunswick: Dalhousie, on the trunks of *Betula*, *Abies*, and *Thuja*. Sterile.

Placodium chrysodetum Vain. also has leprous thallus and positive K (violascens) reaction, but this lichen is exclusively confined to stones and may grow over dead mosses on stones. *Placodium citrinum* (Hoffm.) Hepp., a typical calcareous lichen, may also grow on trees and wooden houses which are impregnated with chalk dust, but is not entirely leprous and its color is "flavo-citrina vel cerina" and it frequently has apothecia.

PHYSCIA CLEMENTIANA (Ach.) Kickx.

Ph. astroidea Nyl.

Thallus albidus vel canus in centro granuloso-sorediosus, $K\dot{+}$ lutescens.—New Brunswick: Dalhousie, on the bark and on the peeled trunks of *Picea*. Sterile.

PHYSCIA STELLARIS (L.) Nyl. New Brunswick: Dalhousie, with the previous species on *Picea*. Sterile.

PHYSCIA STELLARIS var. ROSULATA (Ach.) Nyl. New Brunswick: Dalhousie, on a trunk of *Betula*. Fertile.

PHYSCIA CAESIA (Hoffm.) Nyl. New Brunswick: Dalhousie, with *Placodium elegans* on a field stone. Sterile.

PHYSCIA MUSCIGENA (Ach.) Nyl. British Columbia: Kamloops, on the ground between mosses and grasses in a semi-desert. Sterile.

PHYSCIA MUSCIGENA f. LENTA (Ach.) Vain. British Columbia: Kamloops, with the previous species on the ground in semi-desert. Sterile.

PHYSCIA MUSCIGENA f. SQUARROSA (Ach.) Lynge. Thallus 6–8 cm. latus, imbricatus, albo-pruinosus; laciniae curtae, obtusae, adscendentes. Apothecia 1–3 mm. lata, plana, albo-pruinosa, marginata. Sporae 15–26 × 8–15 μ, fuscae.—British Columbia: Kamloops, with the previous species on the ground in semi-desert.

PHYSCIA GRISEA (Lamy) Zahlbr. var. SEMIFARREA (Vain.) Lynge. British Columbia: Kamloops, on the ground between grasses and *Selaginella*. Sterile.

PHYSCIA PYRITHROCARDIA (Müll.-Arg.) Räs.

Ph. adglutinata var. *pyrithrocardia* Müll.-Arg.

Thallus centrum versus tote isidioso-sorediosus, viridi-griseus, intus erythrinus, K=.—New Brunswick: Dalhousie, on the trunk of *Picea*. Sterile.

PHYSCIA ENDOPHOENICEA (Harm.) Räs. Sicut *Ph. obscura* (Ehrh.) Nyl. f. *ciliata* (Hoffm.) Lynge, sed thallus fusco-niger et intus pulchre rubescens. Thallus $K\mp$ violascens.—New Brunswick: Dalhousie, on trunk of *Betula*, with *Placodium xanthostigmoideum*. Sterile.

RINODINA DEMISSA (Flk.) Mass. New Brunswick: Dalhousie, on a field stone. Fertile.

BUELLIA DISCIFORMIS (Fr.) Mudd var. MINOR (Fr.) Räs. New Brunswick: Dalhousie, on a *Populus* trunk. Fertile.

Buellia disciformis var. insignis (Naeg.) Nyl. f. muscorum (Schaer.) Räs. British Columbia: Kamloops, on mosses growing on stones in a semi-desert. Fertile.

Buellia major (DN.) Mass. New Brunswick: Dalhousie, on trunks of *Sorbus*, *Picea*, and *Abies*. Fertile.

Buellia punctiformis (Hoffm.) Mass. f. chloropolia (Fr.) Vain. British Columbia: Kamloops, on the trunk (bark) of a very well-lighted *Pseudotsuga*. Fertile.

Peltigera variolosa (Mass.) Körb. Subsimilis *Peltigerae aphthosae* sed thallus subtus distincte nervosus et superne marginem versus subpruinosus.—British Columbia: Field, on the ground between mosses and grasses. Sterile.

Peltigera venosa (L.) Körb. British Columbia: Dorreen, on mineral soil in shaded forest. Fertile. In the dozen individuals from Dorreen the apothecia are much smaller (about 1 mm.) than in the Finnish specimens, so that one might regard the American species as a new variety (var. *microcarpa* Räs.).

Peltigera horizontalis (L.) Hoffm. British Columbia: Prince George, Six Mile Lake, on mossy stone walls. Fertile.

Peltigera maurizii Gyeln. (Hedwigia **68**: 1. 1928). Thallus circiter 6 cm. latus, superne laevis, nitidus, epruinosus et etomentosus, cinereus vel cinereo-fuscescens, subtus malaceaeforme nervosus, obscuro-fuscus, marginem versus pallidior; rhizinae nigro-fuscae, fasciculatae, obsoletae. Apothecia horizontalia, plana vel concava, badio-fusca, 3–5 mm. lata; margo subintegra. Sporae 26–43 × 3.5–6 μ, fusiformes, 3-septatae, hyalinae. Hymenium 80–83 μ crassum, sordide-hyalinum, I+ caerulescens.—British Columbia: Field, on ground between mosses and other ground lichens. This easily recognizable lichen is a form intermediate between *Peltigera malacea* and *P. horizontalis*.

Peltigera malacea (Ach.) Fr. British Columbia: Valemount, on an *Arctostaphylos* and lichen heath. On the ground. Sterile.

Peltigera canina (L.) Willd. British Columbia: Kamloops, on mossy stones in semi-desert. Fertile.

Peltigera canina var. membranacea Ach. British Columbia: Field, with *Peltigera Maurizii* and *P. variolosa*, on the ground in a forest of *Picea*. Fertile.

Peltigera canina var. suomensis (Gyeln.) Räs.

P. suomensis Gyeln. (Magyar Bot. Lap. **29**: 34. 1930).

British Columbia: Blue River, on the ground in a burnt-over *Myrtillus* forest. Fertile.

Peltigera rufescens (Weis) Humb. British Columbia: Kamloops, on the ground in semi-desert. Fertile.

Peltigera microphylla (Anders.) Gyeln.

P. perfida Gyeln.

Thallus superne cinereo-fuscescens, laevigatus, nitidus, subtus polydactylaeforme venosus, marginem versus squamuloso-isidiosus. Apothecia junior involuta.—New Brunswick: Dalhousie, on ground in coniferous forest.

Peltigera lepidophora (Nyl.) Bitt. Alberta: Wainwright, on calcareous earth, together with *Cladonia cariosa*, in a desert. Rare and sterile.

Peltigera Nylanderi Gyeln. (Bot. Közlem. **24**: 137. 1927). Thallus pusillus, 1–2 cm. latus, firmus, monophyllus, laciniatus, ad marginem bene limbiformiter sorediosus, subtus caninaeforme venosus.—British Columbia: Kamloops, between mosses on stones in semi-desert. Sterile.

Nephromium subparile Gyeln. (Magyar Bot. Lap. **29**: 24. 1930). Thallus

superne et ad marginem bene granuloso-sorediosus, etomentosus (glaber), subtus glaber, K=.—British Columbia: Kamloops, on stones in semi-desert. Sterile.

NEPHROMIUM LAEVIGATUM Ach. var. PAPYRACEUM (Hoffm.) Nyl. Thallus pusillus, tenuis, superne glaucus, K=, subtus albido-pallens, glaber. Apothecia majora, 3–8 mm. lata, horizontalia, fusca; margo subintegra. Sporae pallidae, 16–21 × 4–5 μ, 1- vel 3-septatae, oblongo-fusiformes.—British Columbia: Aleza Lake, on branches of *Picea* in the forest.

NEPHROMIUM **canadense** Räs., n. sp. Thallus 5 cm. latus, subrigidus, coriaceus, bene laciniatus, ad marginem dentatus vel lacunate dentatus, superne sublaevigatus, apicem versus scabroso-areolatus, passim leviter hirsutus vel totus nudus, griseo-pallidus vel glauco-fuscescens, subtus tomentellus, pallido-fuscescens. Apothecia vulgaria, 3–6 mm. lata, convoluta, fusca; margo dentata. Sporae 3-septatae, pallidae, oblongae vel oblonge fusiformes, 14.5–21 × 7–8 μ. Hymenium 70 μ crassum. I+ caerulescens. Gonidia nostocoidea.—British Columbia: Aleza Lake, together with *Nephromium laevigatum* var. *papyraceum* and *Cyanisticta Hookeri* var. *septentrionalis*, on branches of *Picea* in forest.

SOLORINA SACCATA (L.) Ach. British Columbia: Field, on a tree base. Fertile.

LOBARINA VERRUCOSA (Huds.) Gyeln.

Sticta scrobiculata (Scop.) Ach.

New Brunswick: Dalhousie, on a tree trunk, rare. Sterile.

LOBARIA PULMONARIA (L.) Hoffm. Thallus ad marginem sorediosus, non isidiosus; medulla et soredia K+ flavescentia.—New Brunswick: Dalhousie, on *Abies* and *Betula* trunks. Sterile; British Columbia: Aleza Lake, on branches and trunks of *Picea*. Fertile.

LOBARIA LINITA (Ach.) Rabenh. Thallus esorediatus, K=.—Alaska (regio alpina), on the ground between *Cladonia* species and mosses. Sterile and rare.

LOBARIA OREGANA (Tuck.) Müll.-Arg. Thallus majus, 30 cm. longus et 3–10 cm. latus, dichotome laciniatus, lacunoso-reticulatus, viridi-glaucus, esorediatus, basim versus demum squamulosus; laciniae in apicibus rotundata. Apothecia vulgaria, in centro aut submarginalia, plana aut demum convexa, castaneo- vel rufo-fusca; margo tenuis. Sporae 40–61 × 6–8 μ, hyalinae, fusiformes, 1-septatae. Hymenium 100–120 μ crassum, incoloratum, I+, caerulescens. Hypothecium 60 μ crassum, K+ lutescens. Thallus K∓ lutescens, Cl=, K(Cl)=, I=.—British Columbia: Hazleton, on *Pinus Murrayana*, Dorreen, on *Pseudotsuga*, and Vancouver Is., Lake Cowichan, on trunks of *Thuja* and *Tsuga*.

STICTINA FULIGINOSA (Dicks.) Nyl. British Columbia: Aleza Lake, common on branches of *Picea* in forest. Sterile.

CYANISTICTA HOOKERI (Bab.) Räs. var. **septentrionalis** Räs., var. nov. Thallus superne glauco-cinereus, subnitidus, scrobiculatus, isidiosus, subtus obscure rhizinosus. Pseudocyphellia minora, papilliformia, albida. Gonidia nostocoidea.—British Columbia: Aleza Lake, on branches of *Picea*. Sterile.

COLLEMA NIGRESCENS (Huds.) Ach. New Brunswick: Dalhousie, on *Populus* trunks. Sterile.

LEPTOGIUM TREMELLOIDES (L.) Fr. New Brunswick: Dalhousie, on *Abies* trunks. Sterile.

LEPTOGIUM SATURNINUM (Dicks.) Mass. British Columbia: Kamloops, on side of a stone in semi-desert. Sterile.

PILOPHORON ACICULARE (Tuck.) Nyl. Thallus 2.5–3.5 cm. longus, simplex vel parce ramosus, corticatus, viridis, K+ lutescens. Apothecia sphaeroidea vel sub-

conica, vulgaria, nigra vel caeruleo-nigra. Sporae hyalinae, oblongo-fusiformes, simplices, 18–21 × 5–6 μ. Epithecium caeruleum, K+ smaragdulum. Hypothecium fuligineum. Hymenium 60–130 μ, crassum, incoloratum, I+ caerulescens.—British Columbia: Dorreen, frequent on stones between plant remains (fallen needles, etc.) in mountain forest.

CLADONIA RANGIFERINA (L.) Rabenh. Alaska (regio alpina), on ground. Sterile.

CLADONIA RANGIFERINA f. NIVEA Räs. Thallus niveus, K+ lutescens.—British Columbia: Dorreen, on an arid heath in *Pinus Murrayana* forest. Sterile.

CLADONIA SILVATICA (L.) Rabenh. Alaska (regio alpina), on ground; British Columbia: Dorreen, on an arid heath among *Pinus Murrayana*. Fertile.

CLADONIA SILVATICA var. MITIS (Sandst.) Räs. British Columbia: Valemount, on an arid heath with *Arctostaphylos Uva-ursi*. Sterile.

CLADONIA ALPESTRIS (L.) Rabenh. Alberta: Lake Louise, on an *Empetrum* heath. Common. Sterile.

CLADONIA BACILLARIS Nyl. New Brunswick: Dalhousie, on a very rotten rail fence. Fertile.

CLADONIA CRISTATELLA Tuck. New Brunswick: Dalhousie, in same situation as previous species. Fertile.

CLADONIA DEFORMIS Hoffm. Alberta: Lake Louise, on an arid heath between other *Cladonia* species and mosses. Sterile.

CLADONIA UNCIALIS (L.) Fr. Alaska (regio alpina), on ground; British Columbia: Valemount, on an *Arctostaphylos-Cladina* heath. Fertile.

CLADONIA CRISPATA (Ach.) Flot. var. INFUNDIBULIFERA (Schaer.) Vain. British Columbia: Valemount, with previous species on an *Arctostaphylos-Cladina* heath. Fertile.

CLADONIA CRISPATA var. ELEGANS (Del.) Vain. British Columbia: Blue River, on a burnt-over *Vaccinium Myrtillus* heath. Fertile.

CLADONIA CENOTEA (Ach.) Schaer. var. CROSSOTA (Ach.) Nyl. British Columbia: Valemount, on an *Arctostaphylos-Cladina* heath. Sterile.

CLADONIA CARIOSA (Ach.) Spreng. f. CRIBROSA (Wallr.) Vain. Alberta: Wainwright, on ground in desert with *Peltigera lepidophora*. Fertile. As both species grow on calcareous soil, one may conclude that the soil in these deserts is calcareous.

CLADONIA GRACILIS (L.) Willd. var. DILATATA (Hoffm.) Vain. New Brunswick: Dalhousie, on a very rotten rail fence; British Columbia: Golden, on a sand heath; Valemount, on an *Arctostaphylos-Cladina* heath; Alberta, Lake Louise, on an arid heath. Fertile.

CLADONIA GRACILIS f. ANTHOCEPHALA Flk. British Columbia: Field (regio subalpina), on a *Vaccinium Myrtillus* heath; Blue River, on a *V. Myrtillus* heath, which had been burnt over. Fertile.

CLADONIA ELONGATA (Jacq.) Hoffm. Alaska (regio alpina), on mossy ground. Sterile.

CLADONIA ELONGATA var. ECMOCYNA (Ach.) Räs. Podetia cornuta vel subcornuta, saepe dilatata, scyphifera, glauco-cinerea, K− pulchre lutescentia.—Alberta: Lake Louise, on a dry heath; British Columbia: Field (regio alpina), on heath under *Phyllodoce*, etc. Fertile.

CLADONIA CORNUTA (L.) Schaer. New Brunswick: Dalhousie, on rotten stump of an *Abies*. Sterile.

CLADONIA VERTICILLATA Hoffm. New Brunswick: Dalhousie, on ground. Sterile.

CLADONIA DEGENERANS (Flk.) Spreng. British Columbia: Valemount, on an *Arctostaphylos* heath. Fertile.

CLADONIA SUBCERVICORNIS (Vain.) DR. f. TURGESCENS Magn. (Lich. Sel. Scand. Exs. II, No. 34. 1929). British Columbia: Kamloops, on a desert. Fertile.

CLADONIA PYXIDATA (L.) Fr. var. NEGLECTA (Flk.) Mass. British Columbia: Kamloops, on edge of desert. Sterile.

CLADONIA CHLOROPHAEA (Flk.) Spreng. British Columbia: Kamloops, on ground in desert; Alberta: Wainwright, in desert. Sterile.

CLADONIA FIMBRIATA (L.) Fr. var. SIMPLEX (Weis) Vain. f. MINOR (Hag.) Vain. New Brunswick: Dalhousie, at base of *Picea;* British Columbia: Kamloops, in desert. Sterile.

CLADONIA FIMBRIATA var. SIMPLEX f. MAJOR (Hag.) Vain. British Columbia: Aleza Lake, on *Picea* base. Sterile.

CLADONIA FIMBRIATA var. APOLEPTA (Ach.) Vain. New Brunswick: Dalhousie, on a very rotten rail fence. Fertile.

BACIDIA MINUSCULA Anzi var. BECKHAUSII (Körb.) Vain. Thallus obsoletus. Apothecia minutissima, 0.2–0.3 mm. lata, globosa, tuberculata, nigra, tenuiter pruinosa. Sporae juvenes, 12–18 × 2 μ, 1- to 3-septatae, bacillariae, incoloratae. Hymenium obscure olivaceum, I+ caerulescens, deinde sordide rubescens, 40 μ crassum. Epithecium K+ violascens. Hypothecium pallidum.—British Columbia: Aleza Lake, on bark of *Abies* with *Biatora helvola* and *Opegrapha* sp.

BACIDIA FUSCORUBELLA (Hoffm.) Arn. British Columbia: Aleza Lake, on trunk of a *Picea*. Fertile.

PSORA DECIPIENS (Ehrh.) Körb. British Columbia: Field (regio subalpina), on sandy ground. Fertile.

CATILLARIA TRICOLOR (With.) Th. Fr. British Columbia: Aleza Lake, occasional on twigs of *Pinus Murrayana*. Fertile.

BIATORA SYMMICTERA (Nyl.) Räs. New Brunswick: Dalhousie, on trunks and branches of *Thuja*, *Abies*, and *Sorbus*. Fertile.

BIATORA HELVOLA (Körb.) Th. Fr. British Columbia: Aleza Lake, on bark of *Abies*. Fertile.

LECIDEA GONIOPHILA Flk. U. S. A.: Cody, Wyoming, on sandstone in light in a cactus desert. Fertile.

LECIDEA LAPICIDA (Ach.) Vain. var. SERIATA Th. Fr. U. S. A.: Cody, Wyoming, in same situation as previous species. Fertile.

MYCOBLASTUS MELINUS (Krmplhbr.) Hellb. Thallus albido-cinereus, verruculosus, esorediatus, K+ lutescens. Apothecia nigra, opaca, 0.5–1.5 mm. lata, convexa, immarginata. Sporae binae, hyalinae, ellipsoideae, 46–55 × 25–32 μ. Hypothecium pallidum.—British Columbia: Aleza Lake, on barkless, dry, decorticated twigs of *Picea*.

MYCOBLASTUS SANGUINARIUS (L.) Norm. Thallus viridi-albidus, K−, intus sanguineus. Apothecia nigra, nitida. Sporae 46–61 × 25–31 μ, solitariae. Hypothecium crasse sanguineum.—British Columbia: Aleza Lake, on *Betula* and *Abies* trunks. Fertile.

MYCOBLASTUS SANGUINARIUS var. **Dodgeanus**[1] Räs., var. nov. Thallus albidus, verruculoso-inaequalis, esorediatus, tenuis vel mediocris, K+ auratus, Cl−, I−, intus albidus. Apothecia 1 mm. lata, atra, convexa, opaca, immarginata. Hypothecium tenuiter sanguineum vel pallido-flavescens. Sporae solitariae, magnae, oblongo-ellipsoideae, 85–92 × 26–36 μ.—British Columbia: Aleza Lake, common on bark of *Abies lasiocarpa;* Prince George and Six Mile Lake, on *Betula*.

[1] In honor of Dr. C. W. Dodge.

ACAROSPORA SCHLEICHERI (Ach.) Mass. British Columbia: Kamloops, on sandy ground in a desert. Fertile.

ACAROSPORA MOLYBDINA (Wnbg.) Trevis. U. S. A.: Cody, Wyoming, on sandstone in cactus desert. Fertile.

ACAROSPORA PELTASTICTA Zahlbr. U. S. A.: Cody, Wyoming, with previous species on exposed sandstone in cactus desert. Fertile.

DIPLOSCHISTES BRYOPHILOIDES (Nyl.) Zahlbr. Alberta: Wainwright, on ground over mosses and plant remains. Fertile.

DIPLOSCHISTES **canadensis** Räs., n. sp. Thallus griseo-cinereus, areolata-verruculosus, mediocris, K‡ violaceo-rubescens vel atropurpureus, Cl=, K(Cl) haud roseus, I=. Apothecia 0.5–1 mm. lata, urceolata, atra, haud pruinosa, marginata; margo crenata. Sporae 4 : nae, fuscae vel demum nigrae, muriformes, 19.5–27.5 × 11–13 μ. Hymenium I+ fulvescens. Sicut *D. scruposus* var. *terrestris* sed thallus cum KOH rubescens.—British Columbia: Kamloops, on sandy ground in desert.

GRAPHIS SCRIPTA (L.) Ach. New Brunswick: Dalhousie, on *Abies* trunks; British Columbia: Aleza Lake, on *Abies lasiocarpa*. Fertile.

SPHAEROPHORUS GLOBOSUS (Huds.) Vain. var. LACUNOSUS Tuck. Thallus 7 cm. altus, bene ramosus, pallido- vel olivaceo-fuscus, K=, Cl=, K(Cl)=, I∓ distincte caerulescens. Rami lacunoso-foveolati. Apothecia globosa, subterminalia.—British Columbia: Hazleton, on ground. Fertile.

SPHAEROPHORUS **Tuckermanii** Räs., n. sp. Thallus 5–8 cm. altus, parce ramosus, albidus vel olivaceo-albidus, passim albido-roseus, K−, Cl−, K(Cl)−, I∓ dilute caerulescens, cum ramis primariis, cylindricis, 0.5–1 mm. latis, laevibus et cum ramulis adventiciis, 1–5 mm. longis, sat tenuibus et parcis. Apothecia vulgaria, terminalia, globosa, 1–2 mm. lata. Massa sporalia, nigra. Sporae 8 : nae, sphaeroideae, 5–8 μ, viridi-atrae vel fusco-nigrae. Asci anguste cylindrici.—British Columbia: Hazleton, with previous species on ground between mosses and plant remains.

STAUROTHELE CIRCINATA Tuck. Thallus fusco-niger, areolato-diffractus, ad marginem subradiatus. Apothecia concoloria. Sporae fuscae, binae, murales, oblongo-ellipsoideae, 39–52 × 21–25 μ. Gonidia hymenialia, oblongia, viridia, 8–9.2 × 4 μ.—U. S. A.: Cody, Wyoming, on sandstone with *Acarospora molybdina* and *Squamaria alphoplaca* in a cactus desert.

Index to Genera

ASTRANTHIUM AND RELATED GENERA

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Monographic studies of *Aphanostephus* and *Achaetogeron* have made it necessary to investigate some of the related genera, particularly as to the value of certain morphological characters which are used in generic differentiation. The genera are quite similar in habit but the pappus, which furnishes important diagnostic characters, varies greatly within the group and is on the whole inconspicuous. For this reason it is necessary to make microscopic studies of the minute achenial and pappus characters upon which the differentiation of genera is primarily dependent. In this connection it was desirable to study *Astranthium* and *Keerlia* in detail; and it seems advisable to put on record the results which have been obtained relative to these genera.

Astranthium, a genus of the Compositae belonging to the tribe Astereae, was described by Nuttall in 1841.[1] It contained but one species, *A. integrifolium*, based on *Bellis integrifolia* Michaux.[2] The 'Flora of North America,' published by Torrey and Gray in 1842, relegated *Astranthium* to synonymy. Since that time American and Mexican species have been merged with the genus *Bellis*[3] which is indigenous to the Old World and especially to Europe. Three South American species have been described by Vellozo[4] as occurring in Brazil. Two of these, *Bellis campestris* Vell. and *B. pedunculata* Vell., may well be members of the genus *Spilanthes*. The relationship of the third, *Bellis scandens* Vell., is unknown to me.

Bellis perennis L. is an attractive plant, and for this reason it has been cultivated in the north Atlantic states where it has become naturalized. The American species which have been referred hitherto to the genus *Bellis* are so strikingly different that it seems strange the two generic elements should have been regarded

[1] Nutt. Trans. Am. Phil. Soc. N. S. **7**: 312. 1841.
[2] Michx. Fl. Bor. Am. **2**: 131. 1803.
[3] Torr. & Gray, Fl. N. Am. **2**: 189. 1842.
[4] Vell. Fl. Flum. **8**: *pl. 124–126*. 1827; text, pp. 338, 359, ed. 1881.

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for such a long time as congeneric. The range of *Bellis* in North America is far to the north of *Astranthium integrifolium* (Michx.) Nutt., whose northernmost limit of distribution is in Kentucky. *Bellis perennis* L., on the other hand, is reported from the islands of St. Pierre and Miquelon, off the coast of Newfoundland, south to Pennsylvania, and in northwestern America north to Vancouver Island. Because of the difference in morphological characters it seems advisable to recognize *Astranthium* as a distinct genus.

Six Mexican species have been described under *Bellis*, all of which are here transferred to *Astranthium*, except *B. Garciae* Blake. The first Mexican species was described by Gray in 1852 as *Bellis mexicana*,[5] and in 1881 he transferred *Brachycome xanthocomoides*[6] to that genus. Since then four additional species have been published, namely, *B. purpurascens* Rob.,[7] *B. orthopoda* Rob. & Fern.,[8] *B. mima*, and *B. Garciae* of Blake.[9] Another species is added to this group by the transfer of *Keerlia mexicana* Gray ex Wats.[10] to *Astranthium* where it receives the new name *Astranthium xylopodum* Larsen, because of the earlier *Bellis mexicana* Gray.

Only one species, *Astranthium integrifolium*, occurs in the United States. In 1836 Rafinesque described three species, *Bellis parvifolia*, *Bellis nutans*, and *Bellis ciliata*.[11] The first two are considered synonymous with *Astranthium integrifolium* and the last is regarded as a variety of that species.

The genus *Keerlia*, which is closely related to *Astranthium*, was first described by De Candolle[12] in 1836. It contained three species, *K. linearifolia*, *K. ramosa*, and *K. skirrhobasis*. All three species have been transferred to other genera since that time. *Keerlia linearifolia*, which would ordinarily be interpreted as the generic type, was based on two distinct plants, one collected by Alaman and the other by Schiede. The former was referred to the genus *Xanthocephalum* by Dr. J. M. Greenman who pub-

[5] Gray, Smiths. Contr. [Pl. Wright. pt. 1] 3: 93. 1852.
[6] Gray in Hemsl. Biol. Cent.-Am. Bot. 2: 118. 1881.
[7] Rob. Proc. Am. Acad. 27: 172. 1892.
[8] Rob. & Fern. Proc. Am. Acad. 30: 117. 1894.
[9] Blake, Contr. U. S. Nat. Herb. 22: 593. 1924.
[10] Gray ex Wats. Proc. Am. Acad. 22: 422. 1887.
[11] Raf. New Fl. Am. 2: 23. 1836.
[12] D. C. Prodr. 5: 309. 1836.

lished the new combination *Xanthocephalum linearifolium* (DC). Greenm.[13] The latter, namely, the Schiede plant, on which *Brachycome xanthocomoides* was based and cited in synonymy by De Candolle, was transferred by Hemsley to the genus *Bellis* and published as *Bellis xanthocomoides* Gray ex Hemsley.[14] *Keerlia ramosa*[15] and *Keerlia skirrhobasis*[16] have both been transferred by Gray to the genus *Aphanostephus*.

Since the original publication of the genus by De Candolle the following species have been described: *Keerlia bellidifolia* Gray & Engelm.,[17] *Keerlia effusa* Gray,[18] and *Keerlia mexicana* Gray ex Wats.[19] Of these three species only the first two are retained in *Keerlia*, the third is transferred to *Astranthium*. Although all of the species originally described by De Candolle in *Keerlia* have been excluded from that genus, nevertheless it seems advisable to use *Keerlia* as the generic name for the residue, namely, for those species which have been described subsequently and still remain in that genus. The historical name is thus retained; and the genus is delimited in accordance with Gray's treatment in the 'Synoptical Flora of North America'.[20] Moreover, the name *Bourdonia*, proposed by Greene,[21] falls to synonymy.

General Morphology

The American genus *Astranthium* is morphologically distinct from *Bellis* of the Old World with which it was merged in 1842. In habit the genera are quite different. *Bellis* produces long naked monocephalous peduncles from rosulate clusters of basal leaves, whereas the stems of *Astranthium* are usually branched and seldom entirely naked.

The involucre of *Astranthium* is composed of two or three series of bracts which are usually membranaceous margined.

[13] Greenm. Field Mus. Nat. Hist. Publ. Bot. Ser. **2**: 345. 1912.
[14] Gray in Hemsl. Biol. Cent.-Am. Bot. **2**: 118. 1881.
[15] Gray, Proc. Am. Acad. **16**: 81. 1881.
[16] Gray, Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852.
[17] Gray & Engelm. Proc. Am. Acad. **1**: 47. 1848.
[18] Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 222. 1850.
[19] Gray, Proc. Am. Acad. **22**: 422. 1887.
[20] Gray, Syn. Fl. N. Am. 1^2: 164. ed. 2, 1886 and 1888.
[21] Greene, Erythea **1**: 207. 1893.

The involucral bracts of *Bellis* differ in that they are subuniseriate, more or less united at the base, and distinctly foliaceous throughout. On the whole they are broader than those of *Astranthium* and less acute.

A marked contrast between the two genera is to be found in the receptacle. In *Astranthium* it is a low, convex, cushion-like structure with alveolate surface of a light creamy or whitish color. The receptacle of *Bellis* is distinctly conical. It has a smooth, almost shiny, dark greenish-brown surface which is broken only by the white spots indicating points of achenial attachment, and by depressions which are due to shriveling of the subepidermal tissue (pl. 2, figs. 1 and 7).

The corollas of the disk- and ray-flowers are very similar in these genera. The ray-flowers of *Astranthium* may be said to be proportionately longer than those of *Bellis*. The stamens in both cases are typically asteroid (pl. 2, figs. 2, 3, 4, 8, 9, 10).

The achenes of the genera are similar in outline and size. *Bellis* has achenes with distinct margins, while those of *Astranthium* are without distinct margins and are usually more or less pubescent with glochidiate-tipped hairs.

The pistils are similar in size but differ in the characters of their style-branches. *Astranthium* has long, slender, acute style-branches in contrast to those of *Bellis*, which are only about one-half as long as broad, thick, and obtuse (pl. 2, figs. 5, 6, 11, 12).

The pappus is entirely lacking in *Bellis* and this is also the most usual condition in *Astranthium*. There are, however, certain exceptions. *Astranthium xanthocomoides* has a slight indication of a ring-like crown. The ring-like crown is more noticeable in *A. orthopodum* and becomes conspicuous in *A. mexicanum* var. *chihuahuense* where it is somewhat fluted. This vestigial pappus when present forms an unbroken ring-like crown which is entirely without lacerate margins commonly found in related genera.

Geographical Distribution

The only representative of the genus *Astranthium* occurring in the United States is *Astranthium integrifolium* with its two varieties *ciliatum* and *rosulatum*. The species extends from

Fig. 1. Geographical distribution of *Astranthium* and *Keerlia*.

After the cut of the map had been made material was found which extends the range of two of the species. A specimen of *Astranthium integrifolium* from Chautauqua Co., Kansas, extends the range of the species northwestward into that state. *Keerlia bellidifolia* has been collected in Nueces Co., in southeastern Texas.

Georgia and Kentucky to western Oklahoma and Kansas. The varieties occur in Oklahoma, Arkansas, and Texas.

Mexican representatives of *Astranthium* are scattered throughout Mexico from Chihuahua to Chiapas. There is very little material in American herbaria representing Mexican species. *Astranthium mimum* is known only from the locality in which it was collected originally. *Astranthium purpurascens* was found by C. G. Pringle in San Luis Potosi, but the same species was also collected previously by Dr. A. Ghiesbreght in Chiapas. *Astranthium xylopodum* is reported only from eastern Jalisco where it has been collected by both Dr. Edward Palmer and C. G. Pringle. *Astranthium orthopodum* occurs in the mountains of Chihuahua and in Durango. The oldest Mexican species and the one which is best represented in herbaria is *A. mexicanum*. It extends from Hidalgo to central Oaxaca; and a variety, *chihuahuense*, occurs in northwestern Chihuahua. *Astranthium xanthocomoides* has been reported from Hidalgo and Vera Cruz.

The scattered distribution of *Astranthium* in Mexico is probably an indication of the incomplete representation of the flora of that country in herbaria. Further collections will undoubtedly extend the distribution areas and also add to the number of species.

Two species of the genus *Keerlia* are recognized and both of these occur in south-central Texas. It is not at all unlikely that they will be found in adjacent Mexico. The distribution of the various species representing *Astranthium* and *Keerlia* is shown on the accompanying map.

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The writer wishes to express her appreciation to Dr. George T. Moore, Director of the Missouri Botanical Garden, for the use of the library and herbarium of that institution, and especially to Dr. J. M. Greenman for advice and assistance. Dr. B. L. Robinson and Dr. W. R. Maxon kindly loaned material which was necessary to the study of these genera.

ABBREVIATIONS

The specimens cited in this paper are deposited in the herbaria which are indicated by the following abbreviations:

G = Gray Herbarium of Harvard University.
M = Missouri Botanical Garden Herbarium.
US = United States National Herbarium.

Key to the Genera

A. Heads small, few-flowered.....*Keerlia*
AA. Heads medium-sized, many-flowered.
a. Achenes strongly compressed, not 4-angled.
b. Heads subglobose; rays relatively short.....*Egletes*
bb. Heads not subglobose; rays relatively long.
c. Pappus absent or of a ring-like crown; ray-flowers uniseriate.
d. Receptacle smooth, conical; involucral bracts sub-uniseriate...*Bellis*
dd. Receptacle alveolate, convex; involucral bracts bi–tri-seriate.
.....*Astranthium*
cc. Pappus of a short unequally lacerated crown; ray-flowers in 2 or more series.....*Achaetogeron*
aa. Achenes not compressed, subterete, or distinctly 4–5-angled....*Aphanostephus*

Key to Species of Astranthium

A. Stems erect or suberect from a distinctly ligneous base.
a. Leaves glabrous.....*1. A. mimum*
aa. Leaves more or less pubescent.
b. Stems usually unbranched above.
c. Leaves oblong-elliptic.....*2. A. xylopodum*
cc. Leaves oblanceolate to linear.....*3. A. orthopodum*
bb. Stems usually branched above.
c. Leaves dentate.....*4. A. mexicanum*
cc. Leaves entire.....*4a.* Var. *chihuahuense*
AA. Stems erect or procumbent from an annual or slightly ligneous base.
a. Plants with long slender runners.....*5. A. xanthocomoides*
aa. Plants without long slender runners.
b. Achenes glabrous.....*6. A. purpurascens*
bb. Achenes pubescent with glochidiate-tipped hairs.
c. Leaves not rosulate.
d. Plants not conspicuously branched.....*7. A. integrifolium*
dd. Plants conspicuously branched.....*7a.* Var. *ciliatum*
cc. Leaves rosulate.....*7b.* Var. *rosulatum*

Taxonomy

ASTRANTHIUM

Astranthium Nutt. Trans. Am. Phil. Soc. N. S. **7**: 312. 1841; Benth. & Hook. Gen. Pl. **2**: 265. 1873, as to synonymy.

Bellis Michx. and Am. authors, Fl. Bor. Am. **2**: 131. 1803, not of Linnaeus; Hook. Bot. Mag. **52**: *pl. 3455*. 1835; DC. Prodr. **5**: 304. 1836; Raf. New Fl. Am. **2**: 24. 1836; Torr. &

Gray, Fl. N. Am. 2: 189. 1842; Gray in Hemsl. Biol. Cent.-Am. Bot. 2: 118. 1881; Gray, Syn. Fl. N. Am. 1²: 163. 1884, and ed. 2, 163. 1886 and 1888; Britton & Brown, Ill. Fl. 3: 350. 1898, and ed. 2, 3: 402. 1913; Britton, Manual, 943. 1901, and ed. 2, 1905; Rob. & Fern. in Gray, Manual, ed. 7, 799. 1908; Small, Fl. Southeastern U. S. 1202. 1903, and ed. 2, 1913.

Herbaceous, caulescent, glabrate, or pubescent annuals or perennials. Leaves alternate, sessile or petioled, linear-lanceolate to obovate-spathulate, entire or dentate. Involucre 2–3-seriate, imbricated, appressed, lanceolate bracts usually with lacerately ciliate, membranaceous margins. Heads few- to many-flowered. Ray-flowers pistillate, rays 2–3-dentate. Disk-flowers tubular, perfect, corolla 5-lobed. Style-branches linear-lanceolate, acute, papillose at the tip, stigmatic surfaces confined to the lowermost margins of the style-branches and extending one third of their length. Pappus entirely lacking or an inconspicuous ring-like crown. Achenes obovate, compressed, narrowed at the base, pubescent with glochidiate or emarginate hairs, rarely glabrous.

Type species: *Astranthium integrifolium* (Michx.) Nutt. Trans. Am. Phil. Soc. N. S. 7: 312. 1841, which was based on *Bellis integrifolia* Michx. Fl. Bor. Am. 2: 131. 1803, "ad ripas rivulorum et in collibus umbrosis Tennassée."

1. Astranthium mimum (Blake) Larsen, n. comb.

Bellis mima Blake, Contr. U. S. Nat. Herb. 22: 594. 1924.

Herbaceous perennial, 38–50 cm. high; stems several, simple, erect, monocephalous, greenish, striate, glabrous or sparsely pubescent with spreading hairs; basal leaves few, obovate-oblong, apiculate, narrowed at the base into a slender petiole, 15–20 cm. long, 2–3 cm. wide, somewhat membranous in the dried state; stem-leaves linear-lanceolate, hirsute-ciliate, lower 5–6 cm. long, 4–6 mm. wide, gradually reduced above, the uppermost 1 cm. long, 1 mm. wide; peduncles terminal, monocephalous, enlarged just below the head; involucre 2–2.5 cm. in diameter; bracts 2-seriate, equal, 7 mm. high, linear, acute, sparsely pilose, ciliate; ray-flowers about 60, white, fertile, 3-dentate, about 12 mm. long; disk-flowers yellow, fertile, pappus

none; achenes of ray and disk similar, oblong, compressed, glabrous.

Distribution: State of Durango, Mexico. Known only from type specimen.

Specimens examined:

DURANGO: from Sierra Madre, 30 miles north of Guanacevi, alt. 2440–2745 m., Aug. 18, 1898, *Nelson 4786* (US, No. 332836, TYPE).

2. Astranthium xylopodum Larsen, n. name.

Keerlia mexicana Gray, Proc. Am. Acad. **22**: 422. 1887, not *Bellis mexicana* Gray, Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852.

Perennial from a woody base; stems several, simple, or slightly branched near the top, striate, hirsute with spreading pubescence; peduncles 10–14 cm. long, naked or bearing 1–2 small linear-lanceolate bracts near the inflorescence, hirsute-pubescent; leaves oblong-elliptic, evenly pubescent with appressed hirsute hairs, margins strongly ciliate; involucre 1–2 cm. in diameter; bracts linear-lanceolate, pubescent, margins lacerately ciliate, somewhat membranaceous; ray-flowers fertile, about 20; pappus lacking; achenes 4-nerved, glabrous.

Distribution: known only from the State of Jalisco, Mexico.

Specimens examined:

JALISCO: shaded hillsides near Guadalajara, June 27–July 14, 1893, *Pringle 4418* (M, G); Rio Blanco, July 1886, *Edward Palmer 146* (G, TYPE).

3. Astranthium orthopodum (Rob. & Fern.) Larsen, n. comb.

Bellis orthopoda Rob. & Fern. Proc. Am. Acad. **30**: 117. 1894.

Perennial from a short, thick rootstalk; stems several, decumbent or suberect, 10–20 cm. high, simple or somewhat branched, appressed-pubescent, monocephalous; leaves thick, entire, appressed-pubescent, basal leaves oblong-spathulate, 3–4 cm. long, 3–5 mm. broad, stem-leaves linear-lanceolate, erect, gradually reduced toward the inflorescence; peduncles 3–4.5 cm. long, appressed-pubescent; involucre 10–12 mm. in diameter; bracts 2-seriate, linear-lanceolate, acute, purple-margined, sparsely and somewhat appressed-pubescent, 4–5 mm. long; ray-flowers about 30, 1 cm. long; achenes sparsely pubescent with glochidiate or straight and slightly emarginate hairs; pappus an inconspicuous whitish ring-like crown.

Distribution: western Chihuahua, southward along mountains in the state of Durango, Mexico.

Specimens examined:

CHIHUAHUA: Guachachic, June 25, 1892, *Hartman 523* (G, TYPE); vicinity of Madera, alt. 2250 m., May 27–June 3, 1908, *Edward Palmer 287* (M).

DURANGO: City of Durango and vicinity, Apr.–Nov. 1896, *Edward Palmer 163* (M); Otinapa, July 25–Aug. 5, 1906, *Edward Palmer 425* (M).

4. Astranthium mexicanum (Gray) Larsen, n. comb.

Bellis mexicana Gray, Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852; Gray in Hemsl. Biol. Cent.-Am. Bot. **2**: 118. 1881.

Perennial from a branched ligneous base; stems 15–60 cm. high, several, branched above, striate, pubescent with spreading hairs; leaves appressed-pubescent, those of the stem sessile, entire, or saliently dentate, oblong-linear, gradually reduced toward the inflorescence, basal leaves ellipsoid-spathulate, crenate-dentate, 5–20 cm. long, .8–2.5 cm. broad; involucre .8–1.4 cm. in diameter; bracts 2–3-seriate, cinereous-pubescent, linear-lanceolate, purple-tipped; ray-flowers white, numerous, .5–1.0 cm. long; pappus an inconspicuous ring-like crown or almost obsolete; achenes compressed, pubescent.

Distribution: mountains of south-central Mexico.

Specimens examined:

HIDALGO: Sierra de Pachuca, alt. 3076 m., Aug. 26, 1902, *Pringle 9857* (M).

MEXICO: Apr. 26, 1849, *Gregg 701* (M, TYPE); along brooks, Ixtaccihuatl, March–July 1903, *Purpus 159* (M); moist open woods and meadows about timber line, Ixtaccihuatl, Oct. 1905, *Purpus 1575* (M); "above timber line," Popocatepetl, Oct. 1908, *Purpus 3640* (M).

FEDERAL DISTRICT: Cima, Aug. 24, 1910, *Orcutt 3768* (M); Serrania de Ajusco, alt. 3076 m., Aug. 8, 1896, *Pringle 6442* (M).

MORELOS: Toro, alt. 3015 m., Aug. 5, 1924, *Fisher* (M, No. 914805).

OAXACA: Sierra de San Felipe, alt. 3076 m., June 28, 1894, *Pringle 4719* (M); Sierra de San Felipe, alt. 3076 m., Sept. 1894, *Smith 261* (M).

4a. Var. chihuahuense Larsen, n. var.[22] Plate 3.

Resembles the species in habit but differs from it in that it is much less pubescent; the leaf margins are essentially entire, ciliate; the pappus is more conspicuous than that of the species and consists of a narrow fluted crown; the achenes are glabrous, or glabrate.

[22] **Astranthium mexicanum** (Gray) Larsen var. **chihuahuense** Larsen, n. var., planta herbacea perennis, 6–7 dm. alta, supra ramosa; marginibus foliorum integris vel subintegris; pappo coroniforme, margine irregulariter sinuato-dentato; achaeniis glabris vel glabratis.—MEXICO: canyons of Sierra Madre, State of Chihuahua, Oct. 4, 1888, *Pringle 2015* (M, No. 122921, TYPE).

Distribution: State of Chihuahua, Mexico, known only from the type.

Specimens examined:

CHIHUAHUA: canyons of Sierra Madre, Oct. 4, 1888, *Pringle 2015* (M, No. 122921, TYPE).

5. Astranthium xanthocomoides (Less.) Larsen, n. comb.

Brachycome xanthocomoides Less. Syn. 192. 1832, nomen subnudum; Schlecht. in Linnaea **9**: 265. 1835.

Brachycome xeranthemoides Steud. Nomencl. Bot. ed. 2, 220. 1840, in part (typographical error).

Keerlia linearifolia DC. Prodr. **5**: 310. 1836, in part as to synon.

Bellis xanthocomoides (Less.) Gray in Hemsl. Biol. Cent.-Am. Bot. **2**: 118. 1881.

Annual; stems several, striate, procumbent or ascending, branching, leafy throughout, producing slender runners; leaves spathulate, apiculate, sparsely pubescent, gradually reduced toward the peduncles, 1.5–2.5 cm. long, .3–.8 cm. broad; peduncles 1–6 cm. long, densely pubescent at the base of the involucre; involucre .8–1.2 cm. in diameter; bracts 2-seriate, lanceolate, acute, pubescent along the lower portion of the main axis, membranaceous-margined; ray-flowers white, .5–.8 cm. long, about 16; pappus practically lacking; achenes compressed, pubescent, becoming more or less glabrate.

Distribution: alpine meadows and open woods of east-central Mexico.

Specimens examined:

VERA CRUZ: prope la Jaya (La Hoya), June 29, *Schiede 206* (M, TYPE).

HIDALGO: meadows of Sierra de Pachuca, alt. 2760 m., July 17–28, 1898, *Pringle 6888* (M); alpine meadows, Sierra de Pachuca, alt. 2923 m., Aug. 26, 1902, *Pringle 9858* (M); moist meadows and open woods, Pachuca, July 1905, *Purpus 1344* (M).

6. Astranthium purpurascens (Rob.) Larsen, n. comb.

Bellis purpurascens Rob. Proc. Am. Acad. **27**: 172. 1892.

Perennial; roots of numerous fibers; stems erect, branched, 4–45 cm. high, striate, pubescent with spreading hairs; leaves apiculate, pubescent with spreading hairs, margins somewhat ciliate; lower leaves oblong-ovate, 2.5–4.0 cm. long, 1.5–6 cm. broad; upper leaves linear to linear-lanceolate, gradually reduced, 1 cm. or less in length at the base of the peduncles; peduncles 3–8 cm. long; involucre .8–1.0 cm. in diameter; involucral bracts about 14–16, lanceolate, acute, scarious-margined, only slightly

ciliate near the apex, pubescent along the main axis with a few upwardly appressed hairs; rays 10–15, whitish-purple, .5–.8 cm. long; pappus lacking; achenes glabrous, golden-brown at maturity.

This species is closely allied to *A. integrifolium* (Michx.) Nutt.; the chief difference is to be found in achenial characters. *Astranthium integrifolium* has achenes which are pubescent with glochidiate-tipped hairs whereas *A. purpurascens* (Rob.) Larsen has glabrous achenes.

Distribution: known only from the type locality and Chiapas, Mexico.

Specimens examined:

San Luis Potosi: shaded grassy slopes, barranca of Las Canoas, Aug. 18, 1891, *Pringle 3819* (M, cotype).

Chiapas: without definite locality, coll. of 1864–70, *Ghiesbreght 548* (M).

7. Astranthium integrifolium (Michx.) Nutt. Trans. Am. Phil. Soc. N. S. **7**: 312. 1841.

Bellis integrifolia Michx. Fl. Bor. Am. **2**: 131. 1803; Hook. Bot. Mag. **52**: *pl. 3455*. 1835, in part, exclusive of *Brachycome xanthocomoides* Less.; DC. Prodr. **5**: 304. 1836; Raf. New Fl. Am. **2**: 24. 1836; Torr. & Gray, Fl. N. Am. **2**: 189. 1842; Gray, Syn. Fl. N. Am. 1^2: 163. 1884, and ed. 2, 1886 and 1888; Britton & Brown, Ill. Fl. **3**: 350. 1898, and ed. 2, **3**: 402. 1913; Britton, Manual, 943. 1901, and ed. 2, 1905; Rob. & Fern. in Gray, Manual, ed. 7, 799. 1908; Small, Fl. Southeastern U. S. 1202. 1903, and ed. 2, 1913.

Bellis nutans Raf. New Fl. Am. **2**: 23. 1836.

Bellis parviflora Raf. *Ibid.*

Eclipta integrifolia Spreng. Syst. Veg. **3**: 602. 1826.

Annual, openly branched from near the base, 8–45 cm. high, sparsely pubescent with spreading or subappressed hairs, frequently conspicuously pubescent near the base, leafy throughout; lower leaves oblong-spathulate, 2.5–4.0 cm. long, .8–1.4 cm. broad; stem-leaves oblong-ovate, sparsely pubescent, margins ciliate, 3.5 cm. long, 1.5 cm. broad, gradually reduced toward the base of the peduncle; peduncles 4–9 cm. long, densely pubescent at the base of the involucre; involucre 2-seriate, about .6–1.2 cm. in diameter, bracts lanceolate, acuminate, acute, membranous margins only slightly lacerate, sparsely pubescent along the main

axis with a few spreading hairs; ray-flowers fertile, 16–22, purplish-blue; achenes compressed, pubescent with glochidiate-tipped hairs.

Distribution: sandy soil, south-central Kentucky to northwestern Georgia, westward to southeastern Kansas and eastern Oklahoma.

Specimens examined:

GEORGIA: dry ground, Ringold Road, Chickamauga, May 27, 1911, *Churchill* (M, No. 839094).

MISSISSIPPI: Tchula, Holmes Co., Apr. 18, 1927, *Woodson & Anderson 1555* (M).

KENTUCKY: Bowling Green, May 6, 1892, *Price* (M, No. 122882).

TENNESSEE: West Nashville, May 26–27, 1909, *Eggleston 4422* (M); moist field, Joelton, Davidson Co., July 16, 1922, *Svenson 118* (G); copses around Nashville, May–June, *Gattinger 1297* (M); rocky open hillsides, near Erin, Houston Co., May 24, 1920, *E. J. Palmer 17623* (M, G).

MISSOURI: gravelly barrens, Noel, May 10, 1915, *Bush 7534* (M, G); gravelly barrens, Noel, May 10, 1915, *Bush 7534 A* (M); rocky open ground, near Jane, MacDonald Co., May 23, 1931, *E. J. Palmer 39297* (M); rocky slopes, bald knobs, along creek, near Oasis, Taney Co., June 3, 1931, *E. J. Palmer 39483* (M).

ARKANSAS: river bottoms near Fayetteville, June 1835, *Engelmann 129* [*607*] (M); alluvial soil, waste places, cultivated fields, Fayetteville, May, *Harvey 45* (M); Fayetteville, 1880, *Harvey* (M, No. 122880); Hot Springs, May, 1879, *Soulard* (M, No. 122885); sandy soil, Cotter, Marion Co., June 15, 1914, *E. J. Palmer 5992* (M).

KANSAS: rocky soil, Chautauqua Co., May 7, 1897, *Hitchcock 1055* (M).

OKLAHOMA: in woods and meadows, common near Tishomingo, Johnston Co., Apr. 27, 1916, *Houghton 3549* (G); clay washes, near Ardmore, Carter Co., Apr. 17, 1913, *Stevens 77* (M); Arbuckle Mts., Crusher, May 12, 1916, *Emig 606* (M); Catoosa, May 8, 1895, *Bush 897* (M); Ind. Terr., 1877, *Butler* (M, No. 122886); upland prairies, sandy soil, near Howe, Le Flore Co., May 25, 1931, *E. J. Palmer 39343* (M).

7a. Var. ciliatum (Raf.) Larsen, n. comb. Pl. 4, fig. 1.

Bellis ciliata Raf. New. Fl. Am. **2**: 24. 1836.

Bellis integrifolia Gray, Smiths. Contr. [Pl. Wright. pt. 2] 5: 78. 1853, in part.

Stems several, diffusely branched from near the base, 1–3 dm. high, terminated by long slender peduncles; leaves oblong-spathulate to linear-oblong, reduced to small bract-like leaves at the base of the peduncles, .8–3.0 cm. long, .2–.8 cm. broad, sparsely pubescent with subappressed hairs, margins ciliate; peduncles 4–6 cm. long; involucre .5–.8 cm. in diameter; involucral bracts lance-elliptic, acute, the narrow membranaceous margins lacerately ciliate; ray-flowers about 9–15; achenes pubescent with glochidiate-tipped hairs.

Distribution: from southeastern Oklahoma and southwestern Arkansas to south-central Texas, west to the Pecos.

Specimens examined:

ARKANSAS: moist open ground, Fayetteville, Washington Co., July 6, 1915, *E. J. Palmer 8176* (M); Coal Bank, May 14, 1895, *Bush 895* (M); Redfork, May 14, 1895, *Bush 896* (M).

OKLAHOMA: open woods near Idabel, McCurtain Co., May 18, 1916, *Houghton 3845* (G).

TEXAS: Apr.–May, 1844, *Lindheimer 251* (M); "Pine's Island," May 5, 1903, *Reverchon* (M, No. 122889); *Reverchon 440* in part (M, No. 122890); clay barrens, Bryan, Brazos Co., May 27, 1915, *E. J. Palmer 7785* (M); Pecos and Limpio, June 1851–2, *Wright 1176* in part (M, No. 123093); dry banks, Hempstead, Apr. 24, 1872, *Hall 306* (M).

7b. Var. rosulatum Larsen, n. var.[23] Pl. 4, fig. 2.

Bellis integrifolia Gray, Smiths. Contr. [Pl. Wright. pt. 2] **5**: 78. 1853, in part.

Stems several, sparsely branched near the base, pubescent with spreading hairs, .5–1.5 dm. high; leaves sparsely pubescent with subvillose hairs; basal leaves numerous, forming a rosette, oblong-spathulate, 2–7 cm. long, .5–1 cm. broad; stem-leaves oblong-spathulate to linear-lanceolate, gradually reduced to the base of the peduncle; peduncle 1.5–5 cm. long; involucre about .7 cm. in diameter; bracts lance-elliptic, acute, the narrow membranaceous margins somewhat lacerately ciliate near the apex; ray-flowers about 16; achenes densely pubescent with glochidiate-tipped hairs.

Distribution: central Oklahoma and eastern Texas west to Presidio County.

Specimens examined:

OKLAHOMA: open woods near Mannsville, Johnston Co., May 16, 1916, *Griffith 3455* (M, G); Limestone Gap, Apr. 16, 1877, *Butler 63* (M); Sapulpa, Apr. 28, 1895, *Bush 927* (M); "Arkansas," May 20, 1895, *Bush 929* (M).

TEXAS: sandy prairies, Columbia, Brazoria Co., March 25, 1914, *E. J. Palmer 5028* (M); Victoria, Victoria Co., March 5, 1916, *E. J. Palmer 9070* (M); sandy open ground, Larissa, Cherokee Co., Apr. 7, 1916, *E. J. Palmer 9388* (M); sandy prairies, Matagorda, Matagorda Co., March 5, 1914, *E. J. Palmer 4855* (M, No. 753171, TYPE); on plains, Handley, Apr. 15, 1913, *Ruth 74* (M, G); along railroads near Houston, Apr. 23, 1899, *Eggert* (M, Nos. 122893 & 122895); Terrell, Apr. 6, 1903, *Reverchon 4006* (M); prairies near Victoria, Apr. 7 & 10, 1900, *Eggert* (M, No. 122899); Pecos and Limpio, June 1851–2, *Wright 1176* in part (M, No. 123091); near San Felipe,

[23] **Astranthium integrifolium** (Michx.) Nutt. var. **rosulatum** Larsen, n. var., caule simplice vel basi ramoso, 0.5–1.5 dm. alto, subvilloso; foliis basalibus rosulatis, oblongo-spathulatis, 2–7 cm. longis, usque ad 1 cm. latis, integris, ad apicem rotundatis vel obtusis, sparse pubescentibus; foliis caulinis oblongo-spathulatis vel linearilanceolatis, integris, superne sensim minoribus; pedunculis 1–6 cm. longis.—TEXAS: on sandy prairies, Matagorda, Matagorda County, March 5, 1914, *E. J. Palmer 4855* (M, 753171, TYPE).

Apr. 1839, *Lindheimer* (M, No. 122904); along river, Columbia, Apr. 19, 1899, *Bush 195* (M); on prairie, Chenango Junction, Apr. 18, 1900, *Bush 60* (M); *Reverchon 440* in part (M, No. 122898); open ground, along railway grade near Marfa, Presidio Co., June 18, 1926, *E. J. Palmer 31036* (M).

KEERLIA

Keerlia Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 221, 222. 1850, in part as to *K. bellidifolia* and *K. effusa*, not DC.; Smiths. Contr. [Pl. Wright. pt. 1] **3**: 92. 1852, not DC.; Syn. Fl. N. Am. 1^2: 164. 1884, and ed. 2, 164. 1886 and 1888.

Bourdonia Greene, Erythea **1**: 207. 1893.

Herbaceous, caulescent, pubescent annuals or perennials. Leaves alternate, sessile or petioled, oblong to obovate-spathulate, entire. Involucre of imbricated lanceolate bracts, with membranaceous margins. Heads few-flowered. Ray-flowers in a single series, pistillate, fertile. Disk-flowers tubular, five-lobed, frequently sterile. Branches of the style lanceolate, acutish, hairy toward the tip. Pappus a thickened ring-like or slightly lacerated crown. Achenes compressed, glabrate or hirsute-pubescent.

Type species: *K. bellidifolia* Gray & Engelm. Proc. Am. Acad. **1**: 47. 1848, which was based on No. 415 of Lindheimer, collected above Guadeloupe, Texas, 1845–1846.

Key to the Species

Stems branched from the base.....*8. K. bellidifolia.*
Stems simple to the inflorescence.....*9. K. effusa*

8. Keerlia bellidifolia Gray and Engelm. Proc. Am. Acad. **1**: 47. 1848; Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 220. 1850; Smiths. Contr. [Pl. Wright. pt. 1] **3**: 92. 1852; Syn. Fl. N. Am. 1^2: 164. 1884, and ed. 2, 164. 1886 and 1888.

Bourdonia bellidifolia (Gray & Engelm.) Greene, Erythea **1**: 207. 1893.

Annual; the caudex giving rise to much-branched stems 9–30 cm. high, leafy throughout, striate, pubescent with multicellular spreading hairs; leaves thin, sparsely pubescent, apiculate, lower leaves obovate-spathulate, uppermost somewhat linear, gradually reduced toward the inflorescence, 1–4 cm. long, .4–1.0 cm. broad, narrowed below to a subpetiolate base; heads small; involucre

.3–.5 cm. in diameter, bracts 2–3-seriate, glabrous, linear-lanceolate, acute, with membranaceous margins; ray-flowers 4–15, blue, fertile; disk-flowers 15–20, frequently sterile, style branches shorter than those of the ray-flowers; pappus a thickened ring-like crown; achenes nerved, compressed, glabrate.

Distribution: southern Texas; doubtless also in adjacent Mexico.

Specimens examined:

TEXAS: along Nueces Bay, Nueces Co., alt. 6 m., March 12, 1894, *Heller 1436* (M); Rock Springs, Apr. 17, 1930, *Marcus E. Jones 26575* (M); above Guadalupe, 1845–46, *Lindheimer 415* (M, CO-TYPE); near New Braunfels, May 1848, *Lindheimer 628* (M); Comanche Spring, New Braunfels, Apr. 1850, *Lindheimer 932* (M); rocky calcareous ground, Del Rio, Valverde Co., March 26, 1917, *E. J. Palmer 11384* (M); dry limestone hills, Concan, Uvalde Co., Apr. 13, 1917, *E. J. Palmer 11550* (M); vicinity of San Antonio, Apr. 1919, *von Schrenk* (M, No. 88063); near Austin, March 17, 1908, *York 410* (M).

9. Keerlia effusa Gray, Bost. Jour. Nat. Hist. [Pl. Lindh. pt. 2] **6**: 222. 1850; Smiths. Contr. [Pl. Wright. pt. 1] **3**: 93. 1852; Syn. Fl. N. Am. 1^2: 165. 1884, and ed. 2, 165. 1886 and 1888.

Bourdonia effusa (Gray) Greene, Erythea **1**: 207. 1893.

Perennial, 15–60 cm. high; stem simple below, diffusely branched above into an open glabrous panicle; stem and leaves hispid-pubescent; leaves thin, lowermost leaves obovate-spathulate, 3–9 cm. long, .5–1.3 cm. broad, narrowed at the base into a petiole, those of the stem oblong with a broad, sessile, somewhat amplexicaul base, gradually reduced toward the inflorescence; heads numerous, small; involucre turbinate, 2–3 cm. in diameter; involucral bracts glabrous, 3–4-seriate, linear-lanceolate, acute, membranaceous-margined; ray-flowers 4–7, white, fertile; disk-flowers 6–9, sterile; pappus consisting of a thickened irregularly lacerate crown; achenes compressed, hispid-pubescent.

Distribution: south-central Texas.

Specimens examined:

TEXAS: *Berlandier 499* (M); White Oak Creek, Gillespie Co., *Jermy 815* (M); shady banks of the Upper Guadalupe, 50 miles above New Braunfels, 1847–48, *Lindheimer 629* (M, CO-TYPE); dry hillside thickets, Leakey, Edwards Co., June 10, 1916, *E. J. Palmer 10165* (M); dry hillside thickets, Spanish Pass, Kendall Co., Sept. 28, 1916, *E. J. Palmer 10839* (M); San Geronimo Creek, June 1884, *Reverchon 1534* (M); Comanche Spring, New Braunfels, 1849, *Lindheimer 933* (M).

List of Exsiccatae

The distribution numbers are printed in *italics*. The number in parenthesis is the species number used in this revision.

Berlandier, J. L. *499* (9).
Bush, B. F. *897*, *7534*, *7534A* (7); *895*, *896* (7a); *60*, *195*, *927*, *929* (7b).
Butler, G. D.—(7); *63* (7b).
Churchill, J. R. — (7).
Eggert, H. — (7b).
Eggleston, W. W. *4422* (7).
Emig, W. H. *606* (7).
Engelmann, G. *129* [*607*] (7).
Fisher, G. L. — (4).
Gattinger, A. *1297* (7).
Ghiesbreght, A. *548* (6).
Gregg, J. *701* (4).
Griffith, F. *3455* (7b).
Hall, Elihu. *306* (7a).
Hartman, C. V. *523* (3).
Harvey, F. L. —, *45* (7).
Heller, A. A. *1436* (8).
Hitchcock, A. S. *1055* (7).
Houghton, H. W. *3549* (7); *3645* (7a).
Jermy, Gustav. *815* (9).
Jones, Marcus E. *26575* (8).
Lindheimer, F. *251* (7a); —, (7b); *415*, *623*, *932* (8); *629*, *933* (9).
Nelson, E. W. *4786* (1).
Orcutt, C. R. *3768* (4).
Palmer, E. J. *5992*, *17623*, *39297*, *39343*, *39483* (7); *7785*, *8176* (7a); *4855*, *5028*, *9070*, *9388*, *31036* (7b); *11384*, *11550* (8); *10165*, *10339* (9).
Palmer, Edward, *146* (2); *163*, *287*, *425* (3).
Price, Sadie F. — (7).
Pringle, C. G. *4412* (2); *4719*, *6442*, *9857* (4); *2015* (4a); *6888*, *9858* (5); *3819* (6).
Purpus, C. A. *159*, *1575*, *3640* (4); *1344* (5).
Reverchon, J. —, *440* in part (7a); — (7b); *4006*, *440* in part (7b); *1534* (9).
Ruth, Albert. *74* (7b).
Schiede, G. *206* (5).
Smith, Charles L. *261* (4).
Soulard, Mary. — (7).
Stevens, G. W. *77* (7).
Svenson, H. K. *118* (7).
von Schrenk, H. (8).
Woodson, R. E. Jr., and Anderson, E. S. *1555* (7).
Wright, Charles. *1176* in part (7a); *1176* in part (7b).
York, H. H. *410* (8).

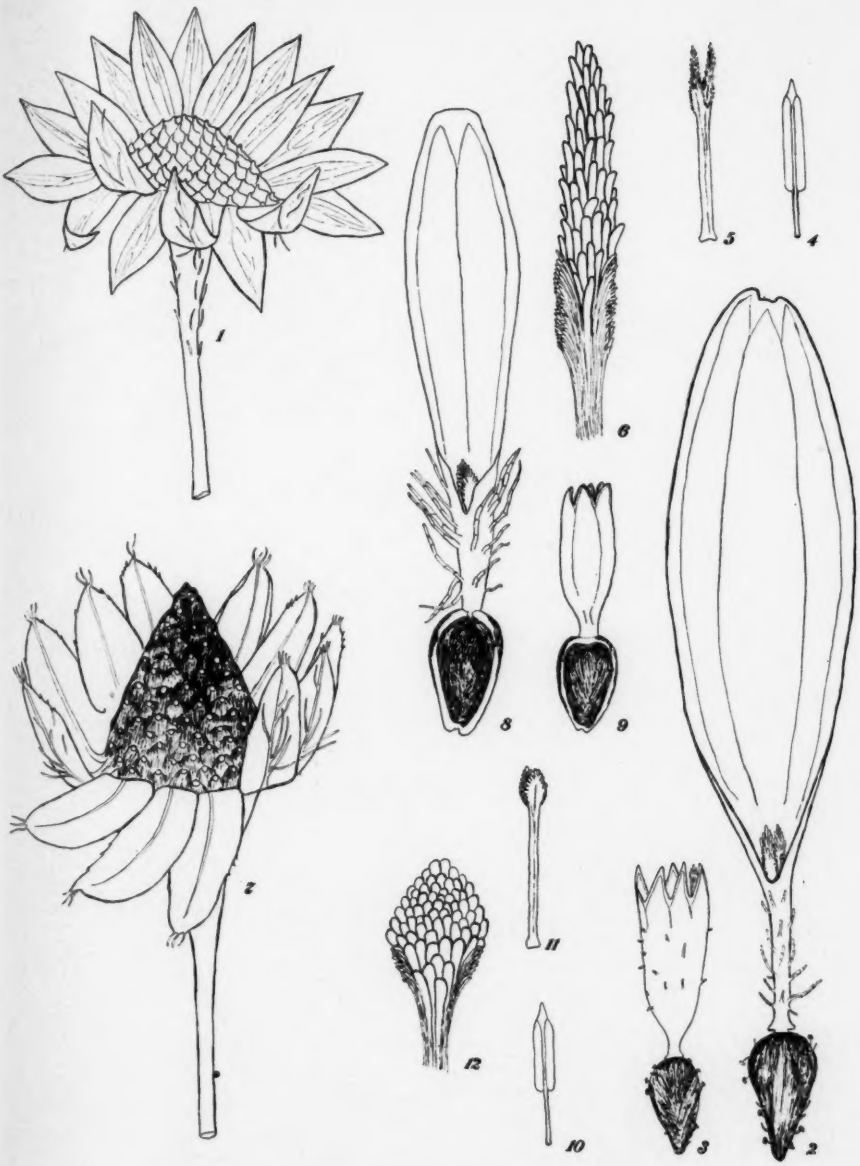
PLATE 2

Astranthium integrifolium (Michx.) Nutt. from *Eggleston 4422* in the Missouri Botanical Garden Herbarium.

Fig. 1. Involucre and receptacle, × 5.
Fig. 2. Ray-flower, × 10.
Fig. 3. Disk-flower, × 10.
Fig. 4. Stamen, × 10.
Fig. 5. Style-branches of the disk-flower, × 10.
Fig. 6. Style-branch greatly enlarged.

Bellis perennis L. from *Pring*, in the Missouri Botanical Garden Herbarium No. 918135.

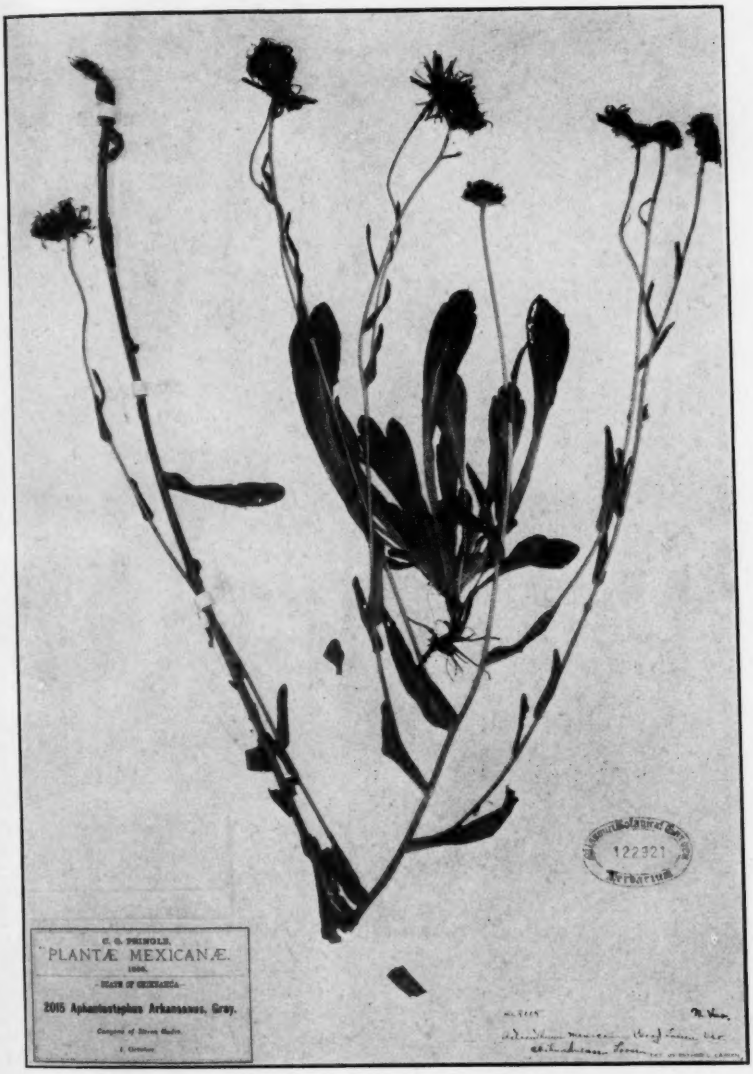
Fig. 7. Involucre and receptacle, × 5.
Fig. 8. Ray-flower, × 10.
Fig. 9. Disk-flower, × 10.
Fig. 10. Stamen, × 10.
Fig. 11. Style-branches of the disk-flower, × 10.
Fig. 12. Style-branch greatly enlarged.



LARSEN—ASTRANTHIUM AND RELATED GENERA

PLATE 3

Astranthium mexicanum (Gray) Larsen var. *chihuahuense* Larsen. From the type specimen, *Pringle 2015*, in the Missouri Botanical Garden Herbarium.



LARSEN—ASTRANTHIUM AND RELATED GENERA

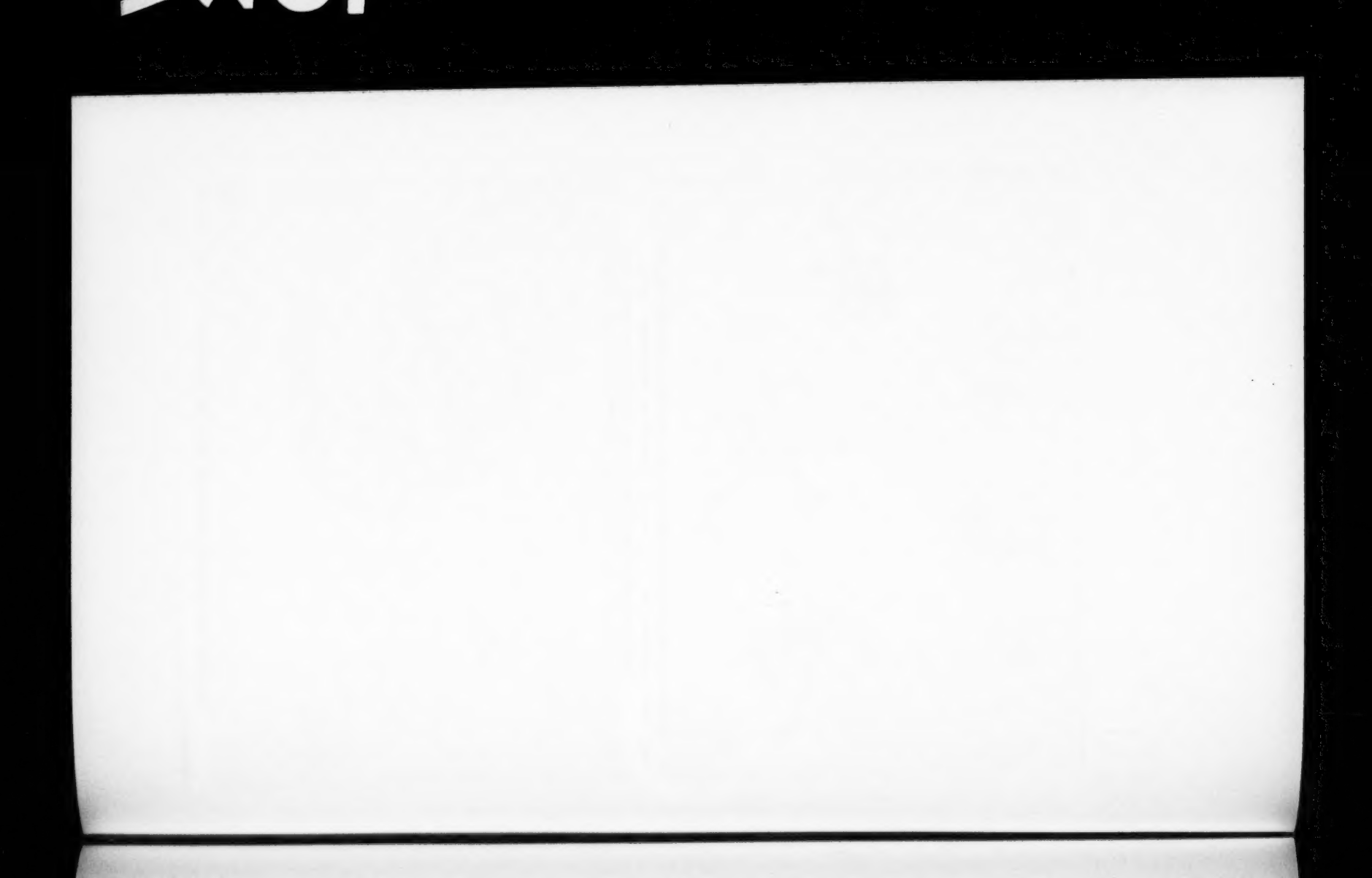
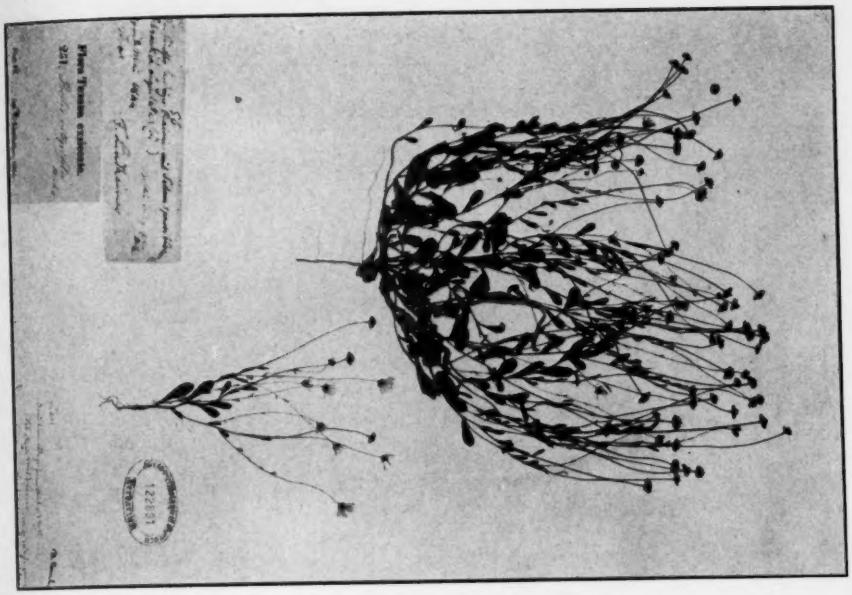


PLATE 4

Fig. 1. *Astranthium integrifolium* (Michx.) Nutt. var. *ciliatum* (Raf.) Larsen. From *Lindheimer 251*, in the Missouri Botanical Garden Herbarium.

Fig. 2. *Astranthium integrifolium* (Michx.) Nutt. var. *rosulatum* Larsen. From the type specimen, *Palmer 4855*, in the Missouri Botanical Garden Herbarium.



FERNS AND FERN ALLIES OF MISSOURI[1]

M. ELIZABETH PINKERTON

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This paper is based primarily upon material in the herbarium of the Missouri Botanical Garden, the University of Missouri, and the private collections of Mr. John H. Kellogg and of the author. After each specific name reference is given to the original publication; this is followed by reference to the two standard manuals and to an illustrated monograph covering the fern-flora of the region concerned, where the species or variety is treated under the same or a different name. These are: Gray, 'New Manual of Botany,' ed. 7, 1908; Britton and Brown, 'Illustrated Flora of the Northern States and Canada,' ed. 1, 1896, and ed. 2, 1913; and Eaton, 'Ferns of North America,' vol. 1, 1879 (*plates 1–45*) and vol. 2, 1880 (*plates 46–81*). Time of fruiting, the general distribution for North America, and the habitat for Missouri in particular precede the specific description. The names of the principal collectors whose material was examined are listed, and definite citations made when the plant is rare.

KEY TO FAMILIES

1. Plants with short vertical stems or rootstocks.....2
1. Plants with horizontally spreading stems or rootstocks.....4
2. Leaves onion-like, producing sporangia at their bases.....*Isoetaceae*
2. Leaves neither onion-like nor producing sporangia at their bases.....3
3. Sporangia borne on under sides of leaves.....*Polypodiaceae*
3. Sporangia borne terminally in special fruiting clusters.....*Ophioglossaceae*
4. Sterile leaves large, usually compound or variously divided.....5
4. Sterile leaves small, often scale-like.....6
5. Fertile segments leaf-like or pod-like; if the latter, sporangia covered with indusia .....*Polypodiaceae*
5. Fertile segments not leaf-like; sporangia naked.....*Osmundaceae*
6. Plants truly aquatic.....*Salviniaceae*
6. Plants terrestrial.....7
7. Stems jointed; sporangia clustered underneath the scales of terminal cone-like spikes.....*Equisetaceae*
7. Stems not jointed; sporangia borne on upper surfaces of leaves.....8

[1] This article is a portion only of a thesis submitted to the Board of Graduate Studies of Washington University in partial fulfillment for the requirements of the degree of master of science.

Issued April 29, 1933.

8. Spores all of the same kind.....*Lycopodiaceae*
8. Spores of two kinds (larger macrospores and much smaller microspores).....*Selaginellaceae*

Ophioglossaceae

1. Veins free; sporangia separate in compound inflorescences.....*Botrychium*
1. Veins reticulate; sporangia disposed in a solitary spike.....*Ophioglossum*

Fig. 1. Key map to distribution chart (fig. 2) showing location of counties in Missouri.

OPHIOGLOSSUM

1. Sterile segments obtuse, usually solitary; middle areoles long and narrow, outer hexagonal and containing a few included veinlets.....*1. O. vulgatum*
1. Sterile segments cuspidate, 2–5; areoles wide and containing many anastomosing veinlets.....*2. O. Engelmanni*

1. Ophioglossum vulgatum L. Sp. Pl. 2: 1062. 1753. Gray, p. 47; Britton & Brown, ed. 1 and 2, 1: 2.

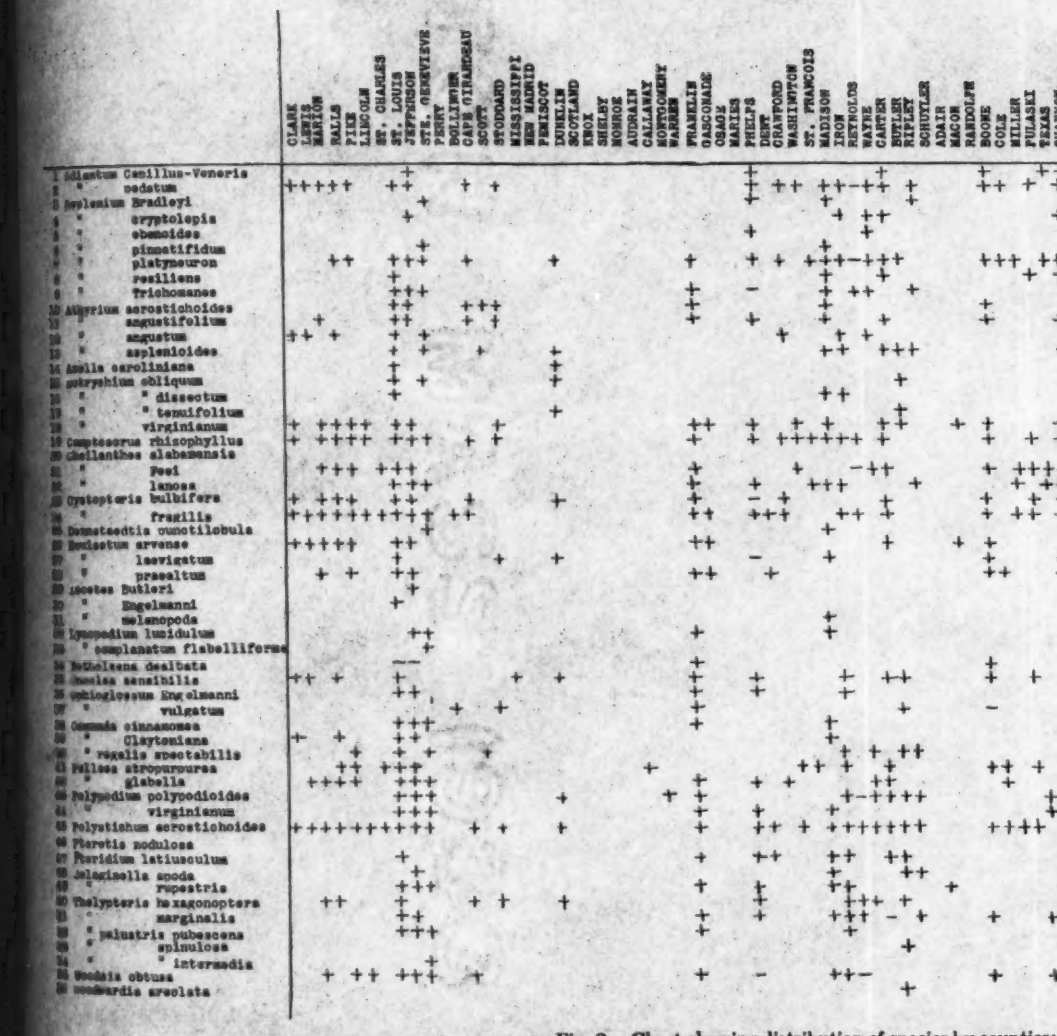

Fig. 2. Chart showing distribution of species by counties:

es by counties: − signifies reported only; +, specimens seen.

Rootstock short, oblique or erect; common stalk half or more above ground, constituting 1/3 to 2/5 the length of the plant; sterile segments sessile, ovate, 1–5 inches long, 0.5–2 inches broad; basal veins about 9; sporophyll 0.75–2 inches long, apiculate. May to August.

Distribution: Nova Scotia to Delaware, westward to Missouri and Texas. Southeastern Missouri—swamps or moist meadows.

Specimens examined: *Palmer 14716, 14732, 14748, 14765.*

2. Ophioglossum Engelmanni Prantl in Ber. Deut. Bot. Ges. 1: 351. 1883. Gray, p. 47; Britton & Brown, ed. 1 and 2, 1: 2.

Rootstock cylindrical; common stalk mostly below ground, sheathed by persistent leaf-bases; sterile segments sessile, elliptic to ovate, 1–3.5 inches long, 0.5–2 inches broad; basal veins 13 or more, transverse ones oblique; sporophyll 0.5–1 inch long, apiculate. March to October.

Distribution: South Carolina to Florida, westward to Arizona. Limestone glades, especially where there is a thin layer of fine rich and damp soil.

Specimens examined: *Palmer, Kellogg, Letterman, Engelmann, Bush, Pinkerton, Eggert, Greenman.*

BOTRYCHIUM

1. Bud wholly enclosed; cells of epidermis straight; sterile blade petiolate and never over 7 inches broad; common stalk mostly underground.....2
1. Bud exposed along one side at base of rootstock; cells of epidermis flexuous; sterile blade sessile, 2–16 inches broad and nearly as long; common stalk above ground, half the length of plant.....4
2. Ultimate segments deeply laciniate.....*2. B. obliquum* var. *dissectum*
2. Ultimate segments serrulate-dentate.....3
3. Plant coarse; common stalk very short, underground; frond membranaceous on drying.....*1. B. obliquum*
3. Plant slender; common stalk up to 2 inches above ground; frond coriaceous on drying.....*3. B. obliquum* var. *tenuifolium*
4. Ultimate segments spatulate-shaped; ripe sporangia straw-colored, opening but slightly in dehiscence.....*5. B. virginianum* var. *intermedium*
4. Ultimate segments acute; ripe sporangia brown, opening widely in dehiscence.....*4. B. virginianum*

1. Botrychium obliquum Mühl. in Willd. Sp. Pl. 5: 63. 1810. Gray, p. 48; Britton & Brown, ed. 1, 1: 3, ed. 2, 1: 5; Eaton, *pl. 20, fig. 2.*

B. ternatum Sw. in Schrad. Jour. für die Bot. 2 (1800): 111. 1801.

B. ternatum var. *obliquum* D. C. Eaton, Ferns N. Am. 1: 149. 1879.

Plant 5–15 inches tall; bud pilose; sterile blade long-stalked, 2–5 inches broad, tripinnatifid or tripinnate below; ultimate segments obliquely ovate or oblong-lanceolate, acutish terminal ones elongate; sporophyll long-stalked, usually stout, several-pinnate. August to October.

Distribution: Maine to Alabama, westward to Michigan and Texas. Moist woods, neutral soil.

Specimens examined: *Palmer, Bush, Kellogg, Letterman, Eggert, Trelease.*

2. Botrychium obliquum var. **dissectum** Prantl in K. Bot. Gard. Berlin, Jahrb. 3: 342. 1884. Gray, p. 49; Britton & Brown, ed. 1, 1: 3, ed. 2, 1: 5; Eaton, *pl. 20, fig. 1.*

B. dissectum Spreng. Anleit. 3: 172. 1804.

B. ternatum var. *dissectum* D. C. Eaton, Ferns N. Am. 1: 150. 1879.

Character of rootstock, fruiting stalks, and texture of the plant all similar to the species; frond subternately divided, basal divisions unequally and broadly deltoid, decompound; the upper and secondary pinnae deltoid-lanceolate, pinnate, with laciniate or deeply cut pinnules; the ultimate divisions divergent, narrow, and incised.

Distribution: Maine to Florida, westward to Illinois and Missouri. Rich moist woods, deeply shaded.

Specimens examined: *Eggert, Letterman, Pinkerton.*

3. Botrychium obliquum var. **tenuifolium** (Underw.) Gilbert in Fern Bull. 11: 99. 1903. Gray, p. 49. Pl. 5, fig. 2.

Plant small, up to 12 inches high; common stalk up to 2 inches high, not all underground, slender; blade ternate with few divisions, 5–10 cm. broad and about 5 cm. long; leaves coriaceous; ultimate segments broad, about 1.5 cm. long, ovate, acutish, conspicuously serrulate. September and October.

Distribution: Virginia to Arkansas. Southern Missouri—swampy land.

Specimens examined: Dunklin Co., *Bush 134*, and coll. of Sept. 28 and Oct. 28, 1897, *Trelease;* Butler Co., *Bush 3110.*

4. Botrychium virginianum (L.) Sw. in Schrad. Jour. für die Bot. 2 (1800): 111. 1801. Gray, p. 49; Britton & Brown, ed. 1, 1: 4, ed. 2, 1: 6; Eaton, *pl. 33.*

Common stalk slender, above ground 1/2–2/3 the length of

plant; blade sessile or nearly so, membranaceous, ultimate segments toothed; sporophyll long-stalked, bi–tripinnate. June and July.

Distribution: New Brunswick to Alabama, westward to Idaho and Texas. Rich moist woods.

Specimens examined: *Davis, Engelmann, Letterman, Palmer, Bush, Pinkerton, Eggert, Kellogg, Trelease, Larsen, Daniels, Emig, Blankenship.*

5. Botrychium virginianum var. **intermedium** Butters in Rhodora 19: 207. 1917.

Ultimate segments of the sterile frond spatulate, penultimate ones ovate, not crowded; segments of the fertile frond opening wide in dehiscence; sporangia straw-colored, up to 0.8 mm. long.

Specimens examined: Monteer, Shannon Co., *Bush 4724;* Whiteside, Lincoln Co., *Davis*, coll. of 1910. The writer feels that the species is so generally variable that this variety is not very distinct.

Polypodiaceae

1. Indusia lacking 2
1. Indusia present, at least in early stages 4
2. Fruit dots near margin, becoming confluent, somewhat protected by overlapping leaf margins; lower surfaces of leaves covered with a white powder. ..... *Notholaena*
2. Fruit dots separate, round, absolutely unprotected 3
3. Fronds linear, once-pinnatifid ..... *Polypodium*
3. Fronds triangular, more than once-pinnatifid ..... *Thelypteris*
4. Fronds dimorphic (fertile fronds not leaf-like) 5
4. Fronds monomorphic 6
5. Sterile fronds pinnatifid; veins anastomosed; fertile segments bipinnate. *Onoclea*
5. Sterile fronds bipinnatifid; veins free and unbranched; fertile segments pinnate ..... *Pteretis*
6. Indusia marginal 7
6. Indusia not marginal 11
7. Indusia not formed of revolute margins, but cup-shaped and opening terminally ..... *Dennstaedtia*
7. Indusia formed in part at least by revolute margins 8
8. Indusia definitely interrupted, occurring in separate little rounded flaps. ..... *Adiantum*
8. Indusia continuous or only slightly broken 9
9. Indusia double ..... *Pteridium*
9. Indusia single 10
10. Blades with a few large, relatively smooth segments ..... *Pellaea*
10. Blades with many small, usually tomentose or hairy segments ..... *Cheilanthes*
11. Sori elongated 12
11. Sori rounded 15
12. Sori dispersed in two rows parallel to the midrib ..... *Woodwardia*

12. Sori dispersed irregularly on lateral veins....13
13. Veins anastomosed....*Camptosorus*
13. Veins free....14
14. Sori straight....*Asplenium*
14. Sori mostly curved over the end of veins....*Athyrium*
15. Indusia peltate....16
15. Indusia attached at base or at one side....17
16. Indusia orbicular, attached centrally....*Polystichum*
16. Indusia reniform, attached at sinus....*Thelypteris*
17. Plants never glandular, but scaly on stipes and rootstocks; segments more or less acute; indusia tapering, attached at one side and becoming obscure at maturity....*Cystopteris*
17. Plants glandular, also scaly; segments obtuse; indusia entire when young, splitting at top into several stellate segments....*Woodsia*

ADIANTUM

1. Main rachis unbranched....*1. A. Capillus-Veneris*
1. Main rachis dichotomously branched with 4-5 pinnae on each side..*2. A. pedatum*

1. Adiantum Capillus-Veneris L. Sp. Pl. **2**: 1096. 1753. Gray, p. 36; Britton & Brown, ed. 1, **1**: 27, ed. 2, **2**: 31; Eaton, *pl. 37*. Venus hair.

Rootstock creeping, chaffy; stipe very slender, 3–12 inches long, black or brownish, slightly scaly; frond ovate-lanceolate, 6–12 inches long, 4–12 inches wide at base; pinnules wedge-obovate or rhomboid, long-stalked, glabrous, membranaceous, margins variously incised, veinlets flabellately forking from base; fruit dots lunate or transversely oblong. June to August.

Distribution: New Jersey to Florida, westward to South Dakota and California. Moist rocky places, ravines, wet limestone cliffs.

Specimens examined: *Kellogg, Daniels, Bush, Palmer, Trelease, Emig, Shepard.*

2. Adiantum pedatum L. Sp. Pl. **2**: 1095. 1753. Gray, p. 35; Britton & Brown, ed. 1, **1**: 27, ed. 2, **2**: 31; Eaton, *pl. 18*. Maidenhair.

Rootstock long, creeping, chaffy; stipe 9–18 inches long, shining, dark brown to black, slightly scaly at base, once-forked at summit, each division bearing on one side only several pinnate divisions (occasionally tri-forked); blade reniform-orbicular, 8–18 inches broad, membranaceous, glabrous; pinnules short-stalked, oblong, triangular or end ones fan-shaped; lower margin entire, all veins proceeding from it, upper margin lobed. June to August.

Distribution: Nova Scotia and Quebec to Georgia, westward to Alaska and California. Moist rich woods.

Specimens examined: *Bush, Davis, Engelmann, Palmer, Trelease, Pinkerton, Woodson, Kellogg, Broadhead, Emig, Mackenzie.*

ASPLENIUM

1. Blades pinnatifid, or only lower segments pinnate; apices long-attenuate.....2
1. Blades 1–3-pinnate; apices not long-attenuate.....3
2. Blades membranaceous; lower midribs black and shining on under side; apices crenate, sometimes proliferous.....*8. A. ebenoides*
2. Blades subcoriaceous; midribs green, herbaceous; prolongations sinuous-margined, not proliferous.....*4. A. pinnatifidum*
3. Blades 1-pinnate only; pinnae of regular shape; margins not deeply dissected. 4
3. Blades 2–3-pinnate or -pinnatifid; pinnae of irregular shape; margins deeply cut.....6
4. Pinnae mostly roundish, not auriculate.....*7. A. Trichomanes*
4. Pinnae oblong or lanceolate, auriculate.....5
5. Stipes and rachises shiny black, slender; pinnae mostly opposite; sori few and nearer margins than costae.....*6. A. resiliens*
5. Stipes and rachises shiny reddish brown, coarse; pinnae mostly alternate; sori numerous, near costae.....*5. A. platyneuron*
6. Stipes and rachises green throughout; ultimate segments few, cuneate; margins fimbriate.....*2. A. cryptolepis*
6. Stipes and rachises shining chestnut-brown; lower pinnae divided into obtuse segments; margins crenate.....*1. A. Bradleyi*

1. Asplenium Bradleyi D. C. Eaton, Bull. Torr. Bot. Club **4**: 11. 1873. Gray, p. 39; Britton & Brown, ed. 1, **1**: 26, ed. 2, **1**: 30; Eaton, *pl. 51, figs, 4-8.*

Rootstock short, covered with narrow acuminate blackish-fuscous scales; fronds 4–7 inches high, oblong-lanceolate; stipes 2–3.5 inches long, dark chestnut and shining, tufted, slender; rachises brown, or green above; pinnae numerous, lower ones no larger than the middle ones, obtuse or acutish, toothed, in the largest fronds pinnatifid into oblong lobes which are toothed at apices; sori short, borne near midveins, becoming confluent; indusia membranaceous, persistent. July to September.

Distribution: New York to Georgia, westward to Missouri and Arkansas. On sandstone or chert outcrops—comparatively rare and local.

Specimens examined: *Palmer, Bush, Trelease, Mackenzie, Greene, Pinkerton, Van Dugen, Shepard.*

2. Asplenium cryptolepis (L.) Fernald in Rhodora **30**: 37.

1928. Gray, p. 39; Britton & Brown, ed. 1, 1: 25, ed. 2, 1: 29; Eaton, *pl. 15, fig. 1.*

Asplenium Ruta-muraria L. Sp. Pl. 2: 1081. 1753.

Rootstock short, creeping, entangled, tufted; fronds 1–6 inches tall; stipes and rachises entirely green or slightly brown at base; blades deltoid-ovate, smooth, subcoriaceous, bi–tripinnate; ultimate segments few, stalked, 3–14 mm. long, narrowly cuneate to roundish obovate; margins deeply fimbriate; veins flabellate, no midveins; sori few (2–4 per pinna), oblong, covering whole segment when mature; indusia delicate with ciliated margin. July to September.

Distribution: Vermont to Georgia, westward to Illinois and Missouri. Shaded limestone cliffs—scarce.

Specimens examined: *Trelease, Palmer, Bush, Russell.*

3. Asplenium ebenoides R. R. Scott, Berkeley in Roy. Hort. Soc. Jour. N. S. 1: 137. 1866. Gray, p. 38; Britton & Brown, ed. 1, 1: 23, ed. 2, 1: 26; Eaton, *pl. 4, fig. 2.*

Rootstock short, creeping, chaffy; fronds up to a foot high; stipes tufted, 4–9 inches long, young ones reddish brown, older ones black, shining, slender; lower rachises dark and shining underneath; blades firm-membranaceous, triangular-lanceolate, variable, 3–12 inches long, 1–3 inches at base, tapering to a long-acuminate apex which may become proliferous, lowest divisions distinct, shorter; sori numerous throughout, mostly single and opening obliquely upwards. August and September.

Distribution: Vermont to Alabama, westward to Missouri. Limestone—rare.

Specimens examined: *Trelease, Russell.*

4. Asplenium pinnatifidum Nutt. Gen. 2: 251. 1818. Gray, p. 38; Britton & Brown, ed. 1, 1: 22, ed. 2, 1: 27; Eaton, *pl. 8, fig. 2.*

Rootstock short, creeping, branched, chaffy; fronds 6–9 inches high; stipes brownish near base and green above, clustered; blades 2–5 inches long, subcoriaceous, herbaceous, lanceolate-acuminate from broad and sub-hastate base, pinnatifid; the basal pinnae sometimes long-attenuate, lower lobes of pinnae roundish-ovate, margin crenate, upper pinnae gradually smaller and more adnate to winged rachises; sori straight, many, be-

coming confluent with age, mostly solitary, occurring also on the slender prolongation. July to October.

Distribution: Massachusetts to Alabama, westward to Missouri; recorded from Georgia and Arkansas. On La Motte sandstone only, in shaded crevices of cliffs.

Specimens examined: *Trelease, Engelmann, Russell, Pinkerton.*

5. Asplenium platyneuron[2] (L.) Oakes in D. C. Eaton, Ferns N. Am. **1**: 24. 1879. Gray, p. 39; Britton & Brown, ed. 1, **1**: 23, ed. 2, **1**: 27; Eaton, *pl. 4, fig. 1.* Ebony spleenwort.

Asplenium ebeneum Ait. Hort. Kew. **3**: 462. 1789.

Fronds 4–20 inches high, fertile ones tall and upright, sterile ones short and spreading; stipes and rachises reddish brown, shining, rather thick; blades linear-oblanceolate, tapering at base, once-pinnate; pinnae 20–40 pairs, lanceolate, 0.5–1.5 inches long, alternate, sessile, auricled on upper or both sides of base, and more or less overlapping rachis; sori 8–15 in number, nearer midveins than margins, becoming confluent. July to September.

Distribution: Vermont to Alabama, westward to Texas and Oklahoma; recorded from Ontario and Colorado. Rocky open woods, preferring alkaline soil.

Specimens examined: *Davis, Kellogg, Engelmann, Eggert, Trelease, Bush, Palmer, Daniels, Pinkerton, Woodson, Russell, Mann, Dewart, Emig, Krause, Meek.*

6. Asplenium resiliens Kunze, Linnaea **18**: 331. 1844. Gray, p. 39; Britton & Brown, ed. 1, **1**: 23, ed. 2, **1**: 27; Eaton, *pl. 36, figs. 5 & 6.*

Asplenium parvulum Mart. & Gal. in Mém. Acad. Brux. **15**: 60. 1842.

Rootstocks with black scales; fronds 4–12.5 inches long; stipes and rachises black and shining, slender; blades normally linear-oblanceolate, pinnate; pinnae 4–12 mm. long, mostly opposite, nearly sessile, upper edges auricled and on lower pinnae both edges auricled, deflexed; blades widest in middle; margins mostly entire or slightly crenate, tendency to incurve slightly; fruit dots nearer outer margins than midribs, nearly parallel to the midribs, oblong, few, sometimes becoming confluent. June to October.

[2] Var. *incisum* (E. C. Howe) Robinson in Rhodora **10**: 29. 1908, has very brittle stipes and the pinnae deeply pinnatifid. This appears to be merely an ecological variation.

Distribution: Massachusetts to Florida, westward to New Mexico. Limestone cliffs.

Specimens examined: *Trelease, Bush, Palmer, Russell, Pinkerton, Drouet.*

7. Asplenium Trichomanes L. Sp. Pl. **2**: 1080. 1753. Gray, p. 39; Britton & Brown, ed. 1, **1**: 24, ed. 2, **1**: 28; Eaton, *pl. 36, fig. 1.* Maidenhair spleenwort.

Rootstocks nearly erect, inconspicuously chaffy with narrow black scales; fronds 3–6 inches high; stipes slender, densely tufted, brownish-purple, polished, rachis similar to tip; blades once-pinnate, linear; pinnae 3–7 mm. long, herbaceous, mostly opposite, roundish, crenate margins, obliquely wedge-truncate at base, attached by narrow points; sori medial or nearer the midveins than margins, 3–6 pairs on outer sides of veins, becoming confluent; indusia membranaceous. July to September.

Distribution: Ontario to Alabama, westward to British Columbia and California; widely distributed but local. Sandstone rocks where plenty of water is available.

Specimens examined: *Kellogg, Letterman, Eggert, Engelmann, Palmer, Russell, Pinkerton, Trelease, Morrison, Rickett, Mackenzie, Blankenship.*

ATHYRIUM

1. Fronds simply pinnate.....*1. A. angustifolium*
1. Fronds more than pinnate.....2
2. Fronds deeply bipinnatifid, margins lightly serrate-crenate.....*2. A. acrostichoides*
2. Fronds usually tripinnatifid, margins deeply and irregularly incised.....3
3. Rhizomes creeping, not densely covered with persistent leaf-bases; fronds widest near base; indusia with glandular cilia; spores nigrescent, wrinkled.....*3. A. asplenioides*
3. Rhizomes horizontal, completely concealed by thick fleshy bases of old fronds; fronds widest near middle; indusia toothed or short-ciliate, never glandular; spores yellow, slightly papillate.....*4. A. angustum*

1. Athyrium angustifolium (Michx.) Milde in Bot. Zeit. **48**: 376. 1886. Gray, p. 39; Britton & Brown, ed. 1, **1**: 24, ed. 2, **1**: 28; Eaton, *pl. 56, fig. 1.* Narrow-leaved spleenwort.

Asplenium pycnocarpon Spreng. Anleit. **3**: 112. 1804.

Asplenium angustifolium Michx. Fl. Bor. Am. **2**: 265. 1803.

Athyrium pycnocarpon Tidestrom, Elys. Marianum, p. 36. 1906.

Rootstocks stout, creeping, with many long, branched rootlets; stipes green except for brown base; fronds 1–2.5 feet long, membranaceous, herbaceous, pinnate; pinnae 2–5 inches long, 20–30 pairs, short-stalked, linear-oblong, attenuate, margins slightly

wavy; fertile pinnae near top, narrower and shorter; sori 20–30 pairs, linear, slightly curved, lying along outer of bifurcated veins; indusia firm, convex, concealed by strongly confluent sori at maturity. August and September.

Distribution: Quebec to Georgia, westward to Michigan and Missouri; recorded from Kansas and Minnesota. Moist woods and shaded ravines, reported occasionally on sandy soil.

Specimens examined: *Davis, Kellogg, Palmer, Eggert, Trelease, Bush, Pinkerton, Daniels, Emig, Glatfelter.*

2. **Athyrium acrostichoides** (Sw.) Diels in Engl. & Prantl, Nat. Pfl. 1[4]: 223. 1899. Gray, p. 39; Britton & Brown, ed. 1, 1: 26, ed. 2, 1: 30; Eaton, *pl. 50.* Silvery spleenwort.

Asplenium acrostichoides Sw. in Schrad. Jour. für die Bot. 2: (1800): 54. 1801.

Asplenium thelypteroides Michx. Fl. Bor. Am. 2: 265. 1803.

Athyrium thelypteroides (Michx.) Desv. in Mem. Soc. Linn. Paris [Prodr. p. 266] 6: 266. 1827.

Rootstocks creeping, horizontal; stipes 8–16 inches long, straw-colored, herbaceous, with a few scales on lower portion; blades lanceolate to ovate-oblong, 1–3 feet long and 6–12 inches broad, narrowed to base, deeply bipinnatifid; ultimate segments distinct, obtuse; margins slightly serrate-crenate; sori 3–6 pairs per segment, arranged more or less evenly along lateral veins, mostly straight, oblong, some double. August to October.

Distribution: New Brunswick to Georgia, westward to Missouri; recorded northward to Minnesota. Rich moist woods, or moist sandy soil.

Specimens examined: *Palmer, Eggert, Davis, Letterman, Broadhead.*

3. **Athyrium asplenioides**[3] (Michx.) Desv. in Mem. Soc. Linn. Paris [Prodr. p. 266] 6: 266. 1827. Gray, p. 40; Britton & Brown, ed. 1, 1: 26, ed. 2, 1: 30; Butters in Rhodora 19: 169. 1917.

Asplenium Athyrium Spreng. Anleit. 3: 113. 1804.

Athyrium Filix-foemina (L.) Roth in Römer's Arch. f. Bot. 2[1]: 106. 1799.

Rhizomes horizontally creeping, partially covered by short persistent leaf bases, the whole structure 1–1.5 cm. in diameter,

[3] This species and *A. angustum* are very difficult to distinguish. It is often necessary to have the whole plant, fruiting and not too mature, to be absolutely certain. I have taken the character of the spore as my ultimate criterion.

with conspicuous projections of new growths before fronds of the current season; stipes long, about equal to the deltoid lanceolate fronds; young growths covered with scales soon deciduous, these small and light tan-colored, cell walls thin and inconspicuous; fronds bipinnate to tripinnatifid, second pair of pinnae commonly the longest, the lowest only slightly shorter; pinnae narrower at base; pinnules variously incised but apex more or less obtuse due to the venation, since two veins usually end on the same level; sori longer and narrower than in *A. angustum*, on the anterior side of anterior vein of each lobe of pinnule, and sometimes on the lower veins, of typical athyroid type, rarely double; young indusia ciliate with multicellular glandular-tipped hairs nearly disappearing at maturity, leaving quite even margins; sporangia stalk frequently supplied with a glandular hair; spores furnished with a somewhat nigrescent, wrinkled exospore. July to October.

Distribution: Massachusetts to Florida, westward to Missouri and Texas. Shaded rich woods or cliffs, sandy soil.

Specimens examined: *Kellogg, Trelease, Palmer, Bush, Soulard, Blankenship.*

4. Athyrium angustum[4] (Willd.) Presl in Rel. Haenk. **1**: 39. 1825. Gray, p. 40; Britton & Brown, ed. 1, **1**: 26, ed. 2, **1**: 30; Butters in Rhodora **19**: 169. 1917.

Asplenium Michauxii Spreng. Syst. **4**: 88. 1827.

Asplenium Filix-foemina (L.) Roth in Römer's Arch. f. Bot. **2**[1]: 106. 1799.

Rhizomes horizontal and somewhat oblique, condensed and completely covered by thick fleshy bases, 2–5 cm. in diameter; stipes up to half as long as the frond, a moderate number of scales persistent, 1 × 1.5 mm., dark opaque with thick darker cell walls and narrow cells; fronds bi–tripinnatifid, middle of fronds widest and lower pinnae much shorter and often deflexed, often large forms and polymorphic; pinnae not narrower at base; pinnules and segments with acute apices, due to one vein ending considerably beyond any of its neighbors; fertile fronds consider-

[4] Butters describes two varieties, namely: var. *elatius* and var. *rubellum*, distinguished chiefly by the dimorphism and thicker texture of the former (a sun form) and the monomorphism and thinner texture of the latter (a shade form). He claims that the latter has a more northerly distribution; but in Missouri the two seem to be purely ecological variations and scarcely worth varietal rank.

ably narrower and more acute than sterile ones; sori short and wide, of typical athyroid type; indusia never glandular but persistently short-ciliate; sporangia stalk rarely bearing glandular hair; spores bright yellow and slightly papillate, no exospore and not wrinkled. June to October.

Distribution: Labrador to Pennsylvania, westward to South Dakota and Missouri. Rich woods.

Specimens examined: *Bush, Davis, Palmer, Engelmann, Kellogg, Eggert, Russell.*

CAMPTOSORUS

1. Camptosorus rhizophyllus (L.) Link, Hort. Berol. **2**: 69. 1833. Gray, p. 40; Britton & Brown, ed. 1, **1**: 21, ed. 2, **1**: 26; Eaton, *pl. 8, fig. 1.* Walking fern.

Rootstocks short, creeping; stipes grouped in tufts, spreading, green, fleshy, 1–6 inches long; blades evergreen, subcoriaceous, 4–12 inches long, base auriculate, cordate or hastate, apex attenuate and filiform, rooting at tips (or from auricles); sori numerous, straight or slightly curved, single and on inside of and parallel to veins, near midribs, on both sides of outer veins and becoming confluent at exterior tips; indusia membranaceous. All year.

Distribution: Ontario to Alabama, westward to Minnesota and Oklahoma. Limestone rocks, usually associated with *Entodon* (a moss).

Specimens examined: *Bush, Davis, Engelmann, Trelease, Kellogg, Daniels, Palmer, Pinkerton, Dewart, Russell, Rickett, Weller.*

CHEILANTHES

1. Fronds relatively smooth.....*1. C. alabamensis*
1. Fronds hairy or tomentose.....2
2. Plants small, 2–6 inches tall, matted; mature stipes nearly glabrous..*2. C. Feei*
2. Plants taller, 4–20 inches, not matted; stipes hirsute.....*3. C. lanosa*

1. Cheilanthes alabamensis (Buckl.) Kunze in Linnaea **20**: 4. 1847. Gray, p. 36; Britton & Brown, ed. 1, **1**: 30, ed. 2, **1**: 34; Eaton, *pl. 57, fig. 7.*

Rootstocks creeping, short, slender, with dark ferruginous scales; stipes black, wiry, slightly villous at base due to fine rusty scales 3–7 mm. long; blades scabrous to smooth, 2–10 inches long, lanceolate, bipinnate; pinnae acuminate, lower ones shorter than those above; pinnules often auriculate; indusia broad, pale but firm, frequently broken by incision of pinnules. August to October.

Distribution: Florida, westward to Missouri and Arizona. Limestone cliffs.
Specimens examined: *Kellogg, Palmer, Bush.*

2. Cheilanthes Feei Moore, Ind. Fil. Gen. 38. 1857. Gray, p. 36; Britton & Brown, ed. 2, **1**: 34; Eaton, *pl. 6, fig. 1.*

Cheilanthes lanuginosa Nutt. in Hk. Sp. Fil. **2**: 99. 1852.

Rootstocks short, clothed with narrow scales of black centers and thin brown edges; fronds 2–6 inches tall; stipes densely tufted, black or brown, originally woolly, becoming glabrous when mature; blades bi–tripinnate, slightly tomentose above and woolly below; pinnules divided into minute rounded segments, densely crowded; indusia herbaceous, continuous. July to October.

Distribution: Wisconsin to Texas, westward to Nevada and Arizona. Limestone cliffs in dry and exposed localities.
Specimens examined: *Davis, Kellogg, Engelmann, Trelease, Bush, Palmer, Daniels, Pinkerton, Morrison, Uphof.*

3. Cheilanthes lanosa (Michx.) Watt in Jour. Bot. **12**: 48. 1874. Gray, p. 36; Britton & Brown, ed. 1, **1**: 31, ed. 2, **1**: 34; Eaton, *pl. 2, fig. 2.*

Cheilanthes vestita Sw. Syn. Fil. 128. 1806.

Rootstocks short, creeping, with pale brown scales; fronds 4–16 inches long; stipes wiry, dark brown, hirsute; blades herbaceous, bipinnate; pinnae hirsute and somewhat glandular; indusia inconspicuous, discontinuous. July to September.

Distribution: New York to Alabama, westward to Oklahoma; recorded from Connecticut and Texas. Sandstone rocks, usually in dry and exposed places.
Specimens examined: *Kellogg, Eggert, Letterman, Palmer, Broadhead, Pinkerton, Muller, Glatfelter, Mackenzie, Swallow, Emig, Blankenship, Link.*

CYSTOPTERIS

1. Pinnae short-stalked on rachises; pinnules at least narrowed at points of attachment; segments ovate, acute, usually variously incised; indusia truncate ..... *1. C. fragilis*
1. Pinnae sessile on rachises; pinnules oblong, obtuse, regularly toothed; indusia round or pointed at apex 2
2. Fronds long-attenuate ..... *2. C. bulbifera*
2. Fronds not long-attenuate ..... *3. C. bulbifera* var. *horizontalis*

1. Cystopteris fragilis[5] (L.) Bernh. in Schrad. Neues Jour.

[5] An exceedingly variable species. Hybridization with *C. bulbifera* might account for some of the aberration. Forms bearing bulblets have been included under this group, as that character does not seem to be a constant feature for *C. bulbifera* alone.

Bot. 1²: 27. 1806. Gray, p. 43; Britton & Brown, ed. 1, 1: 13, ed. 2, 1: 15; Eaton, *pl. 53, fig. 1.*

Filix fragilis Underw. Nat. Ferns, ed. 6, 119. 1900.

Rootstocks elongated, often 4–5 inches long, or shorter and condensed, slender, but covered with persistent leaf-bases, chaffy at apex, scales delicate, ovate, acuminate, ferruginous; stipes in a dense cluster, slender, brittle, 4–6 inches long; blades 6–8 inches long and about half as wide, thin and membranaceous, ovate-lanceolate; basal pinnae commonly narrower than the second and third pairs, apparently bipinnate but segments usually connected by narrowly winged midribs, segments roundish-oval to ovate to rhomboid-ovate to ovate-lanceolate, toothed, dentate or irregularly laciniate; veinlets pinnately arranged on midveins, lower ones forked; sori small, roundish, seated on middle of veins nearest midrib; indusia delicate, rounded, ovate, or occasionally with narrow beak-like points, concealed by mature sporangia; lower pinnae often sterile. May to July.

Distribution: Cosmopolitan. Rocky soil, moist woods, preferring alkaline soil.

Specimens examined: *Davis, Engelmann, Trelease, Bush, Palmer, Pinkerton, Eggert, Kellogg, Woodson, Harrison, Mann, Daniels, Blankenship, Duncan, Williams.*

2. Cystopteris bulbifera (L.) Bernh. in Schrad. Neues Jour. Bot. 1²: 10. 1806. Gray, p. 43; Britton & Brown, ed. 1, 1: 12, ed. 2, 1: 15; Eaton, *pl. 53, fig. 13.*

Filix bulbifera Underw. Nat. Ferns, ed. 6, 119. 1900.

Rootstocks seldom over one inch long, chaffy at apex and covered with persistent leaf-bases; stipes slender, rather brittle, 6–10 inches long; blades submembranaceous but of a brittle rigidity, triangular-attenuate, 1–4 feet long, 3–5 inches broad at base; pinnae attenuated upward, bipinnate at base, upper pinnules attached by winged rachises; pinnae numerous (up to 40 pairs), oblong; pinnules oblong, obtuse, pinnately lobed; sori numerous, all pinnae fertile, arranged in rows along each side of midveins of pinnules, placed on the lowest superior veinlet of each group near its middle and so near the midvein; indusia truncate and fragile, covered by mature sporangia; bulblets sometimes present on the under side of the frond attached near the base of or on the pinnae. July to August.

Distribution: Newfoundland to Georgia, westward to Michigan and Arkansas;

recorded from Utah and Arizona. Rocky soil, preferring limestone, in moist shady situations.

Specimens examined: *Bush, Davis, Kellogg, Trelease, Palmer, Pinkerton, Daniels, Letterman.*

3. Cystopteris bulbifera var. **horizontalis** Lawson in Bot. Soc. Edinb. Trans. **8**: 40. 1866. Pl. 5, fig. 1.

Fronds triangular-lanceolate, broad at base, not more than three or four times longer than broad; pinnae horizontal; lowest pinnules often quite broad with irregularly cut lobes and bearing numerous medium-sized sori along the lateral veins, sometimes almost tripinnate, or pinnules irregularly lobed, merely ovate-lanceolate. May to October.

Distribution: southern Missouri and northern Arkansas. Damp limestone bluffs.

Specimens examined: Ilasco, Ralls Co., *Davis 2663;* Sulphur Springs, Jefferson Co., coll. of Oct. 23, 1898, *Trelease;* Terre Bleue Cr., Ste. Genevieve Co., coll. of Aug. 29, 30, 1898, *Trelease;* Lesterville, Reynolds Co., coll. of June 5, 1929, *Kellogg;* Tecumseh, Ozark Co., *Palmer 32896.*

DENNSTAEDTIA

1. Dennstaedtia punctilobula (Michx.) Moore, Ind. Fil. Gen. 97. 1857. Gray, p. 45; Britton & Brown, ed. 1, **1**: 12, ed. 2, **1**: 14; Eaton, *pl. 44.*

Dicksonia pilosiuscula Willd. Enum. 1076. 1809.

Dicksonia punctilobula Hk. Sp. Fil. **1**: 79. 1846.

Rootstocks extensively creeping, slender, scaleless but finely hairy at tips, irregularly branching with many long slender rootlets; stipes rather stout, light brown, chaffless, slightly puberulent; blades 1–3 feet long, ovate-lanceolate, acuminate, delicately herbaceous, hairy and minutely glandular, tripinnatifid; pinnae numerous, lanceolate, pointed, second pair a little longer than first; pinnules adnate to rachis and usually decurrent on it, rhomboid-ovate, pinnatifid into oblong and obtuse cut-toothed lobes; sori minute, on upper margins of the lobes of the pinnules; indusia cup-like, delicate. August.

Distribution: New Brunswick to Georgia, westward to Illinois and Missouri. Crevices of La Motte sandstone, rare.

Specimens examined: *Trelease, Russell, Eggert, Pinkerton.*

NOTHOLAENA

1. Notholaena dealbata (Pursh) Kunze in Amer. Jour. Sci. II. **6**: 82. 1848, as *Nothochlaena.* Gray, p. 35; Britton & Brown, ed. 1, **1**: 32, ed. 2, **1**: 35; Eaton, *pl. 9, fig. 2.*

Cheilanthes dealbata Pursh, Fl. Am. Sept. **2**: 671. 1814.
Nothochlaena pulchella Kunze in Bot. Zeit. **1**: 633. 1843.
Pellaea dealbata (Pursh) Prantl in Engler's Bot. Jahrb. **3**: 417. 1882.
Notholaena nivea var. *dealbata* Davenp. in Cat. Davenp. Herb. Suppl. 44. 1883.

Rootstocks short, creeping, with narrow brown chaffy scales; stipes 1–4 inches long, tufted, wiry, slender, copper-brown, as are the rachises; blades 2–4 inches long, broadly deltoid-ovate, 4–5-pinnate, all but ultimate segments alternate, those sometimes opposite; segments obovate-oval and entire or several-lobed, 1–2 mm. broad, upper surfaces pale green, coriaceous, lower white and powdery, giving a silvery appearance; sporangia seated on upper portions of the veins; no indusia, but a protection afforded by the slightly turned-back margins. June to September.

Distribution: Missouri and Kansas to central Texas; recorded from Nebraska. Dry calcareous rocks.

Specimens examined: *Daniels, Bush, Palmer, Blankenship.*

ONOCLEA

1. Onoclea sensibilis L. Sp. Pl. **2**: 1062. 1753. Gray, p. 45; Britton & Brown, ed. 1, **1**: 9, ed. 2, **1**: 11; Eaton, *pl. 72, fig. 1.* Sensitive fern.

Rootstocks slender, creeping, rooting freely and often forking; stipes coarse, straw-like, hollow, flattened, light brown when dry; sterile blades triangular or triovate, midribs winged, widening toward the apex, sinuses rounded; lowest segments broadly lanceolate, herbaceous, sensitive to frost; veins conspicuous, reticulate; margins variously rounded, lobed, toothed, serrate or acute; fertile fronds 12–18 inches long, pinnate, contracted; each segment a pouch filled with several sporangia; delicate hood-like indusia. August to November.

Distribution: Newfoundland to Florida, westward to Kansas. Swamps or damp rich soil.

Specimens examined: *Bush, Davis, Eggert, Palmer, Morrison, Muller, Daniels, Blankenship, Mackenzie, Williams.*

PELLAEA

1. Pinnae dichotomously branched at apex.....*3. P. atropurpurea* var. *cristata*
1. Pinnae not branched at apex.....2

2. Stipes smooth, reddish-brown; pinnae usually membranaceous, pale green, short, more or less rounded at both corners and tending to divide at bases into two or more parts.....*1. P. glabella*
2. Stipes scabrous, dark purplish-black; pinnae coriaceous, blue-green, elongate and seldom redivided.....*2. P. atropurpurea*

1. Pellaea glabella Mett., Kuhn in Linnaea **36**: 87. 1869. Gray, p. 37; Britton & Brown, ed. 2, **1**: 33.

Pellaea atropurpurea var. *Bushii* Mackenzie, Flora Jackson County, Mo., p. 5. 1902.

Stipes and rachises brownish-red, smooth or but slightly hairy; fronds simply pinnate above, the lower ternate or rarely quinate (the entire pinnule seems to be breaking at the base—a possible tendency toward compound pinnules); pinnae membranaceous to coriaceous but always pale green. April to October.

Distribution: Ontario and Vermont to Pennsylvania, westward to South Dakota and northern Arkansas. Exposed high places on limestone cliffs.

Specimens examined: *Davis, Eggert, Kellogg, Bush, Palmer, Pinkerton, Trelease.*

2. Pellaea atropurpurea (L.) Link, Fil. Sp. in Hort. Berol. 59. 1841. Gray, p. 37; Britton & Brown, ed. 1, **1**: 29, ed. 2, **1**: 33; Eaton, *pl. 54, fig. 4.*

Rootstock short, densely covered with rusty scales about 2 mm. in length; fronds 4–12 inches long, pinnate or below bipinnate, coriaceous; fertile segments linear, more or less pointed at apex; sterile segments approaching oval, shortly stalked; veins obscure; continuous indusia of reflexed margins. June to September.

Distribution: Connecticut to Florida, westward to South Dakota and Texas. Near small limestone rocks or on top of cliffs where there is loose soil.

Specimens examined: *Davis, Engelmann, Trelease, Broadhead, Bush, Palmer, Pinkerton, Kellogg, Daniels.*

3. Pellaea atropurpurea var. **cristata** Trel. in Rept. Mo. Bot. Gard. **12**: 77. 1901. Gray, p. 37.

Pinnae dichotomously forked.

Distribution: known only from Eureka, Missouri. Limestone.

Specimens examined: Eureka, 1899, *Paul.*

POLYPODIUM

1. Blades smooth, green.....*1. P. virginianum*
1. Blades densely scaly, grayish.....*2. P. polypodioides*

1. Polypodium virginianum L. Sp. Pl. **2**: 1085. 1753. Gray, p. 34; Britton & Brown, ed. 1, **1**: 32, ed. 2, **1**: 36; Eaton, *pl. 31, fig. 1.* Common polypody.

Polypodium vulgare L. Sp. Pl. **2**: 1085. 1753.

Rootstocks close to surface of soil, covered with chaffy, red-brown scales; stipes smooth, herbaceous, light green; blades ovate-oblong or narrowly oblong, subcoriaceous or chartaceous, evergreen, simple, deeply pinnatifid, smooth; segments linear-oblong, obtuse or slightly acute, crenulate and serrate, sinuses rounded, alternate, margins obscurely dentate; sori large, naked. July.

Distribution: Newfoundland to Florida, westward to Minnesota and Arkansas. On sandstone or sandy soil.

Specimens examined: *Eggert, Russell, Engelmann, Trelease, Pinkerton, Letterman, Greene.*

2. Polypodium polypodioides (L.) Hitchc. in Rept. Mo. Bot. Gard. **4**: 156. 1893. Gray, p. 34; Britton & Brown, ed. 1, **1**: 33, ed. 2, **1**: 36; Eaton, *pl. 26, fig. 2.* Gray polypody.

Polypodium incanum Sw. Fl. Ind. Occ. **3**: 1645. 1806.

Rootstocks woody, covered with small dark brown scales; stipes 1–4 inches long, slender, bearing peltate ovate scales with dark brown centers; blades oblong-lanceolate, pinnate; segments oblong, obtuse, entire, sessile, separated by rounded sinuses, alternate, upper surfaces smooth or with few scales, lower densely scaly; fruit dots small and naked. July to September.

Distribution: Massachusetts to Florida, westward to Missouri and Texas. Usually an epiphyte on swamp trees, particularly *Taxodium distichum;* also on sandstone rocks.

Specimens examined: *Eggert, Trelease, Bush, Pinkerton, Rickett, Kellogg, Mackenzie, Meek.*

POLYSTICHUM

1. Margins serrulate; fertile pinnae contracted; sori confluent....*1. P. acrostichoides*
1. Margins deeply toothed or pinnatifid; fertile pinnae scarcely contracted; sori not confluent and appearing only on tips of lower pinnae.....
.....*2. P. acrostichoides* var. *incisum*

1. Polystichum acrostichoides (Michx.) Schott, Gen. Fil. 17. 1834. Gray, p. 40; Britton & Brown, ed. 1, **1**: 14, ed. 2, **1**: 16; Eaton, *pl. 34.* Christmas fern.

Aspidium acrostichoides Sw. Syn. Fil. 44. 1806.

Dryopteris acrostichoides Kuntze, Rev. Gen. Pl. **2**: 812. 1891.

Rootstocks stout, creeping, with persistent leaf-bases; stipes densely tufted, with chaff of large golden-brown scales, 5–7 mm. wide; blades lanceolate, pinnate, 1–2 feet long, 3–5 inches wide, rigid, evergreen, subcoriaceous; pinnae numerous, 1–3 inches long, oblong-lanceolate, short-stalked, upwardly falcate or lowest slightly deflexed, apex acutish, upper sides auriculate; margins serrulate to incised with incurved bristle-pointed teeth; veins free, branching three to four times; upper pinnae of fertile fronds more or less contracted and heavily soriferous; sori terminal on lower veinlets in 2–4 rows, becoming confluent with age; indusia round, indurated, not glandular, persistent. July to August.

Distribution: Maine to Florida, westward to Michigan and Texas; recorded from Nova Scotia. Shady hillsides of ravines, in rich soil which is interspersed with rocks; common.

Specimens examined: *Bush, Davis, Eggert, Trelease, Palmer, Pinkerton, Emig, Kellogg, Daniels, Thomas, Mackenzie.*

2. Polystichum acrostichoides var. **incisum** Gray, Man. Bot. ed. 1, 632. 1848. Gray, p. 40; Britton & Brown, ed. 1, **1**: 14, ed. 2, **1**: 16.

Polystichum acrostichoides var. *Schweinitzii* (Beck) Small in Bull. Torr. Bot. Club **20**: 464. 1893.

Aspidium schweinitzii Beck, Bot. North. & Mid. States, ed. 1, 449. 1833.

Aspidium acrostichoides var. *incisum* D. C. Eaton, Ferns N. Am. **1**: 258. 1879.

Segments few and distant, large, irregularly incised; upper pinnae covered by confluent sori, lower ones fertile at tips only, sori large; veins numerous, frequently overlapping to form irregular areoles.

Distribution: This seems to be nearly as common as the type in southern Missouri and northern Arkansas; but since there appears to be a series of intermediate forms between the two I have not attempted to separate the individual ranges.

PTERETIS

1. Pteretis nodulosa (Michx.) Nieuwl. in Am. Midl. Nat. **4**: 334. 1916. Gray, p. 45; Britton & Brown, ed. 1, **1**: 9, ed. 2, **1**: 11; Eaton, *pl. 73*. Ostrich fern.

Osmunda Struthiopteris L. Sp. Pl. **2**: 1066. 1753.

Onoclea Struthiopteris Hoffm. Deutsch. Fl. **2**: 11. 1795.

Struthiopteris germanica Willd. Enum. 1071. 1809.

Matteuccia Struthiopteris (L.) Todaro in Syn. Pl. Acot. Vasc. Sicilia, p. 30. 1866.

Matteuccia nodulosa (Michx.) Fernald in Rhodora **17**: 164. 1915.

Rootstocks stout and ascending, with slender underground stolons; sterile blades 2–7 feet high, 6–15 inches broad, short-stalked, broadly oblanceolate, abruptly short-acuminate, gradually narrowed below middle, lower pinnae reduced; pinnae narrow, deeply pinnatifid; segments oblong, obtuse, entire; veins simple, fertile blades 1–7.5 feet high, with pod-like brown pinnae, included sori confluent. July.

Distribution: Newfoundland to New York, westward to Michigan and Missouri; recorded from Virginia. Alluvial soil.

Specimens examined: Livonia, Putnam Co., *Bush 7780, 7780A, 7780B.*

PTERIDIUM

1. Pinnules much elongated, seldom redivided. . . .*2. P. latiusculum* var. *pseudocaudatum*
1. Pinnules oblong-lanceolate, at least a few pinnatifid. . . . . *1. P. latiusculum*

1. Pteridium latiusculum (Desv.) Hieron. Wissenschaftl. Ergeb. d. Schwed. Rhodesia-Kongo-Exp. 1911–12, Heft 1, p. 7. 1914; Maxon in Am. Fern Jour. **9**: 43. 1919. Gray, p. 36; Britton & Brown, ed. 1, **1**: 28, ed. 2, **1**: 32; Eaton, *pl. 35.*

Pteris aquilina L. Sp. Pl. **2**: 1075. 1753.

Pteridium aquilinum Kuhn in Decken, Reisen in Ost-Afrika 3^3: 11. 1879.

Rootstocks cord-like, creeping, blackish, deeply buried; stipes solitary, erect, naked, 1–3 feet high, swollen at base, brownish; blades 2–4 feet long, 1–3 feet broad, triangular-ovate, rigidly subcoriaceous, subternate; the long-stalked basal pinnae and middle ones bipinnate, those above lobed or simple; segments oblong-lanceolate, under surfaces glabrous or pubescent; veins close-packed, free; indusia continuous around the edge of the pinnules, double. July to September.

Distribution: Cosmopolitan, open woods, preferring sandy soil.

Specimens examined: *Kellogg, Eggert, Palmer, Bush.*

2. Pteridium latiusculum var. **pseudocaudatum** Maxon in Am. Fern Jour. **9**: 44. 1919. Gray, p. 36; Britton & Brown, ed. 2, **1**: 32.

The variety occurs in this region but does not seem to have a distribution different from that of the species. It is distinguished by its very narrow elongated pinnules.

THELYPTERIS

Dryopteris Adans.
Polystichum Roth
Aspidium Swartz
Nephrodium Richard
Lastrea Bory
Phegopteris (Presl) Fée

1. Indusia absent.....*5. T. hexagonoptera*
1. Indusia present.....2
2. Blades bipinnatifid or bipinnate; segments not spinulose.....3
2. Blades tripinnatifid or tripinnate; segments spinulose.....4
3. Sori medial, small; blades membranaceous, not evergreen.....*1. T. palustris* var. *pubescens*
3. Sori near margins, large; blades subcoriaceous, evergreen.....*2. T. marginalis*
4. Indusia glandless; pinnae decidedly oblique to rachises, scales of stipe pale brown.....*3. T. spinulosa*
4. Indusia glandular; pinnae more or less at right angles to rachises; scales of stipe brown with a dark center.....*4. T. spinulosa* var. *intermedia*

1. Thelypteris palustris var. **pubescens**[6] (Lawson) Fernald in Rhodora 31: 34. 1929. Gray, p. 41; Britton & Brown, ed. 1, 1: 15, ed. 2, 1: 18; Eaton, *pl. 30.* Marsh shield-fern.

Thelypteris Thelypteris Nieuwl. in Am. Midl. Nat. 1: 226. 1910.

Rootstocks slender, creeping, blackish, nearly naked; stipes as long or longer than the blades, blackish at base, sparingly chaffy; blades oblong-lanceolate, pinnate, 1–3 feet long, 4–6 inches wide, membranaceous, scarcely narrowed at base, short-acuminate; pinnae 20–30 pairs, alternate, short-stalked, approximately at right angles to stalks, linear-lanceolate, broadest at base, deeply pinnatifid; segments oblong-obtuse, mostly entire; veins pinnate, usually once-forked; fertile fronds usually on longer stalks and of narrower segments than the former; sori nearly medial, crowded; indusia glabrous. August.

[6] Eaton mentions an unusual form—"the lower two or three pairs are usually but little shorter than those above them; but fronds are occasionally found in which they are conspicuously reduced." Such a form is one from Iron Lake, Iron Co., *Kellogg 1634.*

Distribution: New Brunswick to Florida, westward to Texas. Wet woods.
Specimens examined: *Eggert, Kellogg, Bush, Pinkerton.*

2. Thelypteris marginalis (L.) Nieuwl. in Am. Midl. Nat. **1**: 226. 1910. Gray, p. 42; Britton & Brown, ed. 1, **1**: 17, ed. 2, **1**: 20; Eaton, *pl. 55*. Evergreen wood fern.

Rootstocks stout, ascending, covered with long chaffy brown scales; stipes several inches to a foot long, light tan, somewhat chaffy; blades 6–30 inches long, evergreen, subcoriaceous, ovate-lanceolate, scarcely narrowed at base, deeply bipinnatifid; pinnae numerous, practically sessile, lanceolate, acuminate, slightly broader above the base; pinnules adnate to narrowly winged secondary rachis, oblong to oblong-lanceolate, faintly crenately-toothed; veins free, forked or pinnately branched; sori large, near margins of segments; indusia hard, orbicular-reniform, glabrous, dark brown. July to August.

Distribution: Nova Scotia to Georgia, westward to Kansas and Oklahoma. Sandstone ledges where it is moderately moist.
Specimens examined: *Letterman, Engelmann, Eggert, Kellogg, Palmer, Pinkerton, Muller, Rickett, Mackenzie, Broadhead, Link, Blankenship, Trelease.*

3. Thelypteris spinulosa (Retz.) Nieuwl. in Am. Midl. Nat. **1**: 226. 1910. Gray, p. 43; Britton & Brown, ed. 1, **1**: 18, ed. 2, **1**: 21; Eaton, *pl. 68*. Spinulose shield-fern.

Rootstocks stout, creeping, chaffy; stipes 4–14 inches long, chaffy; blades 0.5–3 feet long, ovate-lanceolate to oblong, acuminate, bi–tripinnate, firmly membranaceous; primary pinnae short-stalked, lower pairs triangular-ovate to triangular-lanceolate, remaining pinnae gradually narrower in outline; secondary rachises narrowly wing-margined; pinnules oblong, subacute, incised with spinulose-serrate lobes; sori small, sub-marginal, terminal on veinlets; indusia flat, round-reniform, glandless.

Distribution: Labrador to Virginia, westward to Idaho. Moist woods, alluvial soil.
Specimens examined: Neeleyville, Butler Co., coll. of Oct. 30, 1899, *Russell.*

4. Thelypteris spinulosa var. **intermedia** (Retz.) Nieuwl. in Am. Midl. Nat. **2**: 278. 1912. Gray, p. 43; Britton & Brown, ed. 2, **1**: 22.

Similar to the species except for the glandular indusia and right-angled relation of pinnae to rachis.

Distribution: In Missouri—more northern, sandy soil.

Specimens examined: Pickle Springs, Ste. Genevieve Co., *Pinkerton 1;* and coll. of May 21, 1930, *Kellogg.*

5. Thelypteris hexagonoptera (Michx.) Weatherby in Rhodora 21: 179. 1919. Gray, p. 35; Britton & Brown, ed. 1, 1: 19, ed. 2, 1: 23; Eaton, *pl. 65.* Broad beech-fern.

Phegopteris hexagonoptera (Michx.) Fée, Gen. Fil. 243. 1850–2.

Rootstocks elongated, slender, creeping, chaffy with gold scales; stipes 8–20 inches long, slender, greenish, or straw-colored; blades triangular, 7–12 inches long, 7–15 inches wide, thinly herbaceous, deep green, slightly hairy or granular, bipinnatifid; pinnae adnate to winged rachis, the lowermost ones broadest and largely ovate to ovate-lanceolate, and others lanceolate; segments usually bluntly acuminate and crenate; veins pinnate and free, branched or not; sori borne over whole frond, small, near end of veins and so near margins; no indusia. August.

Distribution: New Brunswick to Delaware, westward to Oklahoma. Moist woods and ravines.

Specimens examined: *Davis, Eggert, Palmer, Kellogg, Bush, Pinkerton, Rickett, Link.*

WOODSIA

1. Woodsia obtusa (Spreng.) Torr. Cat. Pl. in Geol. Rept. N. Y. 195. 1840. Gray, p. 44; Britton & Brown, ed. 1, 1: 11, ed. 2, 1: 14; Eaton, *pl. 71.*

Rootstocks short, creeping, chaffy with narrow light brown scales; stipes 2–6 inches long, green with darkish base in living plants and drying to a bright brownish straw color; fronds 8–15 inches long, broadly lanceolate, narrower at base than in middle, abruptly terminating at tip, membranaceo-herbaceous, minutely glandular, deep blue-green in color, nearly bipinnate; pinnae remote, short-stalked, obtuse, triangular, ovate to oblong, mostly opposite; segments oblong, obtuse, crenately toothed; sori subterminal on veins, nearer margin than midveins; young indusia subglobose, splitting into several irregular lobes which extend out beyond the sporangia, difficult to detect. September.

Distribution: Vermont to Alabama, westward to Wisconsin and Texas; recorded from Nova Scotia. Moist calcareous or acid soil.

Specimens examined: *Davis, Kellogg, Palmer, Pinkerton.*

WOODWARDIA

1. Woodwardia areolata (L.) Moore, Ind. Fil. Gen. 45. 1857. Gray, p. 38; Britton & Brown, ed. 1, **1**: 20, ed. 2, **1**: 25; Eaton, *pl. 22, fig. 2*.

Lorinseria areolata (L.) Presl in Epim. Bot. 72. 1849.

Acrostichum areolatum L. Sp. Pl. **2**: 1069. 1753.

Woodwardia angustifolia J. E. Smith in Mem. Acad. Turin **5**: 411. 1793.

Rootstocks creeping, several to 12 inches long, often branched, less than 1/4 inch thick, with some scales near apex; stipes dark at base, paler above, bearing a few scales, dimorphic; sterile fronds 9–10 inches long, oblong-ovate, pinnate, bright green above, paler below; rachis winged from tip to just below base of blades; sinuses rounded, segments acute, 1–4 inches long, 0.5–1 inch wide, finely serrate, membranaceous; veins finely reticulated, with a longitudinal row of narrow areoles along each side of midribs and midveins, and several rows of hexagonal aeroles and free veins running outwards to serrated edges; fertile fronds taller, with a darker stalk; segments and wing of rachis much narrowed; one row of areoles on each side of midribs, each covered by a brown involucre attached to the outer enclosing veins and open along midrib; sporangia also from enclosing veinlets; sterile fronds appearing in May and fertile ones later. August to October.

Distribution: Massachusetts to Florida, westward to Missouri and Texas; recorded from Maine. Swamps and moist soil.

Specimens examined: Poplar Bluff, Butler Co., July, 1898, *Eby*.

EQUISETACEAE

EQUISETUM

1. Stems annual; dimorphic ..... *1. E. arvense*
1. Stems perennial; monomorphic 2
2. Sheaths cylindrical, green, turning gray, with black lines at bases and tops, short and undilated, splitting with age; ridges almost smooth; often very large plants ..... *2. E. praealtum*
2. Sheaths funnel-shaped, green with narrow black limbs, elongate, not splitting; ridges with one row of tubercules; medium-sized plants ..... *3. E. laevigatum*

1. Equisetum arvense L. Sp. Pl. **2**: 1061. 1753. Gray, p. 52; Britton & Brown, ed. 1, **1**: 36, ed. 2, **1**: 39.

Rootstock tuberiferous, felted with brown wool, extensively creeping; fronds dimorphic; sterile ones annual, prostrate or erect, green, rather slender, 12–24 inches high, 6–19 furrowed, with scattered stomata; sheaths whitish, tipped with about 12 acuminate, brown, separate teeth; branches whorled, simple or compound, not drooping, the 3–4 angled sheaths of branches consisting usually of 4 teeth, or often 3, rarely 5, long and acuminate; fertile fronds annual, appearing in early spring before sterile ones, usually unbranched, succulent, and withering after spores are ripe, 4–10 inches high, light brown, sheaths conspicuous, long, flaring and pointed, of 8–12 teeth; spikes not apiculate; variable. May.

Distribution: Greenland to Alabama, westward to Alaska and California. Sandy soil, in waste places, along streams, etc.

Specimens examined: *Davis, Kellogg, Bush, Daniels, Palmer, Letterman, Eggert, Trelease, Daniels, Mackenzie.*

2. Equisetum praealtum[7] Raf. Fl. Ludovic. 13. 1817. Gray, p. 53; Britton & Brown, ed. 1, 1: 38, ed. 2, 1: 41.

Equisetum hyemale var. *robustum* A. A. Eaton in Fern Bull. 11: 74. 1903.

Hippochaete prealta (Raf.) Farwell in Mem. N. Y. Bot. Gard. 6: 467. 1916.

Equisetum robustum A. Br., Engelm. in Amer. Jour. Sci. 46: 88. 1844.

Fronds perennial, evergreen, 3–11 feet high, erect; stems rough, 20–48 ridges bearing silica in single rows; sheaths cylindrical, short-appressed, not dilated or only slightly when young,[8] at first green but soon turning black or gray with black bands above and below, splitting with age; sheath segments normally tricarinate; teeth dark and caducous; cones pointed. May.

[7] Schaffner (Am. Fern Jour. 13: 33–41. 1923), says: "Although perennial, *E. praealtum* usually bears cones on shoots of the season. Shoots sterile the first year may bear cones the second, both terminal and on lateral branches. Branching is rare the first season unless the shoot is injured, but the second year branching is common even on uninjured shoots. *E. praealtum* is an exceedingly variable species, some forms recognized probably being genetic and some ecological, but none of these forms passes out of the specific limits as usually drawn. Some are short and robust; some tall and massive; some very slender."

[8] Young shoots are often very difficult to distinguish from *E. laevigatum.*

Distribution: Quebec to Georgia, westward to British Columbia and New Mexico. Wet sandy places.

Specimens examined: *Davis, Engelmann, Bush, Palmer, Pinkerton, Eggert, Trelease, Daniels, Throuse, Demetrio.*

3. Equisetum laevigatum A. Br., Engelm. in Amer. Jour. Sci. 46: 87. 1844. Gray, p. 53; Britton & Brown, ed. 1, 1: 38, ed. 2, 1: 42.

Fronds perennial, erect, mostly simple, pale green, 1–5 feet high, 14–30 ridged, almost smooth, with stomata in two rows on each side of depressions; sheaths funnel-shaped, elongated, and green with usually a narrow black band at the top; white-margined teeth soon deciduous; cones pointed. May to June.

Distribution: New York to North Carolina, westward to Washington and California. Along streams, especially in sandy soil.

Specimens examined: *Engelmann, Bush, Daniels, Eggert, Palmer.*

OSMUNDACEAE

OSMUNDA

1. Sterile fronds truly bipinnate; pinnules stalked and widely separated..... .....*1. O. regalis* var. *spectabilis*
1. Sterile fronds bipinnatifid.....2
2. Fronds dimorphic; sterile pinnae with tufts of brown hairs at base; apices of fronds and pinnae tapering; veins inconspicuous.....*2. O. cinnamomea*
2. Fronds monomorphic but fertile part of frond is the middle several pairs of pinnae; no tufts of hair at base of pinnae; apices of fronds and pinnae abruptly narrowed and scarcely acute; veins dark-colored, conspicuous. .....*3. O. Claytoniana*

1. Osmunda regalis var. **spectabilis** Fernald in Rhodora 32: 72. 1930. Gray, p. 46; Britton & Brown, ed. 1, 1: 5, ed. 2, 1: 7.

Rootstocks stout, creeping, covered with persistent leaf-bases; fronds 2–6 feet high, stipes never chaffy, green or yellow, rounded on back, flattened on front; blades ovate-oblong, bipinnate; pinnae mostly opposite, ovate; pinnules unequal, 6–12 pairs plus the terminal one, subcoriaceous, short-petioled, distant, oval-oblong or oblong-lanceolate, ultimate ones often auriculate on lower side, margins crenulate-serrate, apex obtuse or subacute; apical pinnae fertile, bipinnate, ultimate divisions thread-like, containing no chlorophyll, entirely covered with sporangia. May to July.

Distribution: Newfoundland to Florida, westward to Saskatchewan and Mississippi. Lowlands, swamps, marshes, and wet woods.

Specimens examined: *Eggert, Palmer, Kellogg, Bush, Pinkerton, Engelmann, Trelease, Mackenzie.*

2. Osmunda cinnamomea L. Sp. Pl. 2: 1066. 1753. Gray, p. 47; Britton & Brown, ed. 1, 1: 5, ed. 2, 1: 7.

Rootstocks creeping, massive, bearing circular clusters of sterile leaves with one or more fertile ones within; fronds dimorphic, sterile ones 1 foot or more high, oblong-lanceolate, acuminate, tapering, deeply pinnatifid; pinnae oblong-lanceolate, acute, tapering, tomentose tuft at base of each pinna; pinnules obtuse, subcoriaceous, green; veins inconspicuous, veinlets once-forked near midvein; margins entire or obscurely crenulate; fertile fronds about as tall as the sterile, bipinnate, and covered with cinnamon-colored sporangia, arising early in the spring preceding the sterile ones. May and June.

Distribution: Newfoundland, westward to Minnesota and New Mexico. Sandstone.

Specimens examined: *Eggert, Trelease, Kellogg, Pinkerton, Russell.*

3. Osmunda Claytoniana L. Sp. Pl. 2: 1066. 1753. Gray, p. 46; Britton & Brown, ed. 1, 1: 6, ed. 2, 1: 8.

Rootstocks creeping, stout, with imbricated leaf-bases; stipes several inches to 2 feet long, woolly when young but never chaffy; fertile fronds taller than the sterile and in the midst of the crown formation, oblong-lanceolate, 1–4 feet long; lowest pinnae about half as long as middle ones, acute and often rounded; pinnae barely acute, never acuminate, short-stalked, lanceolate from a broad base; pinnules close; 2–6 pairs of fertile pinnae near middle of frond, shorter than sterile pinnae and deflexed in a mature specimen, closely bipinnate, woolly, covered with bivalvular reticulated sporangia. May to July.

Distribution: Newfoundland to North Carolina, westward to Minnesota and Missouri. Swamps and moist woods, moist sandstone ledges.

Specimens examined: *Bush, Eggert, Davis, Palmer.*

Lycopodiaceae

Lycopodium

1. Sporophylls segregated into slender cones; habit of plants fan-like.....
.....*3. L. complanatum* var. *flabelliforme*

1. Sporophylls not differing from vegetative leaves; habit of plants rope-like.....2
2. All the leaves broadest above the middle; margins jagged.....*1. L. lucidulum*
2. Shorter leaves broadest at base; margins entire or slightly denticulate.....
.....*2. L. lucidulum* var. *porophilum*

1. Lycopodium lucidulum Michx. Fl. Bor. Am. **2**: 284. 1803. Gray, p. 55; Britton & Brown, ed. 1, **1**: 40, ed. 2, **1**: 44.

Stems assurgent from decumbent persistent bases giving rise to a few vertical stems; leaves dark green and shining, widespread or becoming deflexed, acute, broadest above middle, erose-denticulate, arranged in alternating series of long and short members, the latter often entire and usually bearing the sporangia; gemmiferous. August to October.

Distribution: Newfoundland to Delaware, westward to Alaska and Washington. On sandstone only, usually associated with *Sphagnum*.

Specimens examined: *Kellogg, Eggert, Pinkerton.*

2. Lycopodium lucidulum var. **porophilum** (Lloyd & Underw.) Clute, Fern Allies, p. 3. 1905. Gray, p. 55; Britton & Brown, ed. 2, **1**: 44.

Lycopodium porophilum Lloyd & Underw. in Bull. Torr. Bot. Club **27**: 150. 1900.

Essentially like *L. lucidulum* except that the shorter leaves are broadest at the base and the margins are nearly smooth, and are not deflexed.

Distribution: in the same places as the species. Sandstone.

Specimens examined: Terre Bleue Cr., Ste. Genevieve Co., coll. of Aug. 29, 1898, *Trelease*, and *Pinkerton 31*.

3. Lycopodium complanatum var. **flabelliforme** Fernald in Rhodora **3**: 280. 1901. Gray, p. 57; Britton & Brown, ed. 1, **1**: 43, ed. 2, **1**: 48.

Rhizomes slender, creeping, with numerous erect stems which branch irregularly, giving rise to a flattened fan-shaped vegetative structure, about a foot high with 4-ranked imbricated scale-leaves, those of the two lateral rows broad, with spreading tips, of the upper row narrow and incurved, and of the lower row minute deltoid-cuspidate; peduncles long, dichotomously branched at tips and bearing a number of slender cones about an inch long. August and September.

Distribution: Greenland to West Virginia, westward to Alaska and Idaho. Open pine woods on sandy soil.

Specimens examined: Pickle Springs, Ste. Genevieve Co., *Kellogg 8718*.

SELAGINELLACEAE

SELAGINELLA

1. Plants bearing ill-defined strobili; leaves dimorphic, 4-ranked.....*1. S. apoda*
1. Plants bearing distinct strobili; leaves of one kind, spirally arranged.*2. S. rupestris*

1. Selaginella apoda (L.) Fernald in Rhodora **17**: 68. 1915. Gray, p. 58; Britton & Brown, ed. 1, **1**: 45, ed. 2, **1**: 49.

Selaginella apus (L.) Spring in Mart. Fl. Bras. **1**²: 119. 1840.

Stems prostrate and creeping, 1–4 inches long, pale green, delicate; leaves of two kinds, four-ranked and spreading, the smaller pointed and appressed to the stem; no distinct cones; fertile leaves near tip of branches, those containing macrospores conspicuously bulged. July to September.

Distribution: Massachusetts to Florida, westward to Michigan and Louisiana. Moist shaded places, among grasses.

Specimens examined: *Eggert, Bush, Palmer, Mackenzie.*

2. Selaginella rupestris (L.) Spring in Mart. Fl. Bras. **1**²: 118. 1840. Gray, p. 57; Britton & Brown, ed. 1, **1**: 44, ed. 2, **1**: 49.

Stems densely tufted, bearing occasional sterile runners; all leaves alike, narrow, appressed, and imbricated, bristle-tipped, gray-green; strobili four-sided. August to October.

Distribution: Quebec to Alabama, westward to Minnesota and Oklahoma. In dry exposed places where there is a little soil, sandstone, or chert.

Specimens examined: *Eggert, Russell, Bush, Palmer, Pinkerton, Greene, Broadhead, VanIngen, Shepard.*

ISOETACEAE

ISOETES

1. Megaspores reticulate; sporangia unmarked.....*1. I. Engelmanni*
1. Megaspores tuberculate; sporangia marked in some way.....2
2. Megaspores less than 480 μ in diameter; sporangia marked with brown spots. .....*2. I. melanopoda*
2. Megaspores more than 480 μ in diameter; sporangia marked with brown lines. .....*3. I. Bulleri*

1. Isoetes Engelmanni A. Br. in Flora **29**: 178. 1846. Gray, p. 61; Britton & Brown, ed. 1, **1**: 48, ed. 2, **1**: 53.

Corms 2-lobed; leaves 15–60, 13–50 cm. long, light green; sto-

mata numerous; peripheral strands variable in number or none; sporangia oblong, unspotted, with narrow velum; megaspores white, 400–570 μ in diameter, distinctly marked with honeycomb network of narrow ridges; microspores 21–30 μ, seldom 33 μ, in length, smooth to minutely roughened.

Distribution: eastern border to Mississippi valley. Near ponds.
Specimens examined: *Engelmann.*

2. **Isoetes melanopoda** Gay and Dur. in Bull. Soc. Bot. Fr. 11: 102. 1864. Gray, p. 61; Britton & Brown, ed. 1, 1: 48, ed. 2, 1: 54.

Corms 2-lobed; leaves 15–60, 15–40 cm. long, slender, erect, firm, bright green, usually black and shining at base, with usually pale membranaceous border, little (2–3 cm.) extended above sporangium level; stomata present; peripheral strands 4–6 cardinal, plus as many as 14 accessory groups; ligule subulate, triangular; sporangia oblong, 0.5–3 cm. long, marked by numerous brown spots; velum variable, from very narrow to covering half of sporangium; megaspores 280–440 μ in diameter, marked with low tubercules, frequently confluent into short low wrinkles; microspores frequently ashy-gray, 20–30 μ long, fine-spinulose.

Distribution: Illinois to Texas. Wet prairies.
Specimens examined: *Pfeiffer, Bush, Palmer.*

3. **Isoetes Butleri** Engelm. in Bot. Gaz. 3: 1. 1878. Gray, p. 61; Britton & Brown, ed. 1, 1: 48, ed. 2, 1: 54.

Corms 2-lobed; leaves 8–30, 8–15 cm. long, more slender and rigid than *I. melanopoda*, tapering to apex; stomata numerous; peripheral strands usually 4, sometimes more in number; ligule elongated, cordate at base; sporangium oblong, 6–7 mm. long, marked with brown lines; velum very narrow; megaspores variable, commonly 480–650 μ in diameter, marked with numerous tubercules, usually distinct, occasionally confluent; microspores 27–37 μ long, papillose.

Distribution: Tennessee, westward to Kansas and Oklahoma. Limestone barrens.
Specimens examined: *Eggert, Bush, Palmer.*

Salviniaceae

AZOLLA

1. **Azolla caroliniana** Willd. Sp. Pl. 5: 541. 1810. Gray, p. 50; Britton & Brown, ed. 1, 1: 35, ed. 2, 1: 38.

Plants floating on surface of water, often covering large areas, deltoid or triangular-ovate in outline, 6–25 mm. broad, pinnately branched; lobes ovate, lower lobe reddish, upper greenish with a reddish border; megaspores minutely granulate with three accessory corpuscles; masses of microspores armed with rigid septate processes.

Distribution: Lake Ontario to Florida, westward to Washington and California. On surface of still waters.

Specimens examined: *Eggert, Engelmann, Trelease, Bush, Mackenzie.*

INDEX TO SPECIES[1]

[1] Names in *italics* are synonyms.

EXPLANATION OF PLATE

PLATE 5

Fig. 1. *Cystopteris bulbifera* var. *horizontalis* Lawson. From *E. J. Palmer No. 32896*, in the Herbarium of the Missouri Botanical Garden.

Fig. 2. *Botrychium obliquum* var. *tenuifolium* (Underw.) Gilbert. From Dr. William Trelease, coll. of October 28, 1897, in the Herbarium of the Missouri Botanical Garden.

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PINKERTON—FERNS OF MISSOURI

BLASTOMYCOSIS: REPORT OF A CASE, WITH A STUDY OF AN ETIOLOGIC FACTOR AND A CLASSIFICATION OF THE ORGANISM

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INTRODUCTION

It is the purpose of this paper to describe briefly the disease known clinically as blastomycosis, and to try to clarify the recognition of the organism involved. The literature of the field is at present too extensive for an entire review, and since numerous workers have already given excellent discussions on the clinical aspects of the infection, as to its gross pathology, microscopic histo-pathology or cellular reactions, and the biological or rather immunological phenomena, a review would be unnecessary here. However numerous such papers may be, there is still much work to be done on the subject.

The author has attempted to clear up, at least in his own mind, several undecided points in the disease: first, the establishment of the etiological agent of blastomycosis; second, the determination of the exact classification of the organism. In the past, and even at the present, medical men have grouped under one general heading all organisms which were responsible for the same clinical condition. Good as this system may be for general diagnosis, much difficulty is encountered because of the fact that physicians are inclined to devote very little time to a study of the organism, thus rendering any therapeutic measures, if available, indefinite, inasmuch as several of the fungi present varying degrees of pathogenicity and require different therapeutic measures.

Thus we find that numerous species of the genera *Saccharomyces*, *Monilia*, *Cryptococcus*, *Endomyces*, *Sporotrichum*, and others have, at one time or another, been considered etiological agents of blastomycosis. A review of the history will illustrate these facts.

HISTORY

Years before the first case was definitely described as blastomycosis, investigators had performed a certain amount of work on

fungi involved in cases of infection and had established these organisms as etiological factors, particularly the yeast and yeast-like groups.

Chronologically, the list is quite long, but it is worthy of note. According to Hufschmitt, Sartory, Sartory, and Meyer ('31), we find that in 1845 Remak, and in 1853 Robin, in his 'Histoire Naturelle des Végétaux Parasites de l'Homme et des Animaux,' discovered the normal existence of the yeast *Cryptococcus guttulatus* in the rabbit intestine. A few years previously, Hannover (cited in Buschke and Joseph, '28) had found yeast in the urine of diabetic patients. Investigations then tended to turn to the parasitism of these organisms in animals, with the result that Bernard during the course of his work on fermentations attempted the first animal experiment by injecting beer yeast into these subjects. Following this work, Popoff, Grohe, Roussy, and several others showed the pathogenic actions of the yeasts on mammals, and Rivolta in 1873 in his 'Parasiti Vegetali' demonstrated for the first time a yeast infection in a horse. In the meantime, Metchnikoff and Weismann showed the parasitism of the Saccharomycetaceae in the lower animals. In 1892 Wernicke showed the first mycosis in man and named it "maladie protozoique de la peau." The following year Troisier and Achalme ('93) definitely established the relation between yeasts and man. In the meantime, several workers attempted to show the destructive ability of these organisms on the animal tissues. Popoff in his work had used dogs as his subjects, but impure cultures. Raum ('91) inoculated animals with large amounts of yeasts, and a rise in their temperature, shortness of breath, and death resulted. Neumayer ('91) fed animals with cultures and also inoculated them subepidermally. His feeding developed a gastro-enteritis which he believed due to fermentation, since the skin inoculations were of no value. The yeasts of these workers were probably of the non-pathogenic types, for L. Rabinowitsch ('96), a few years later, showed fifty various yeast-like organisms with seven pathogenic for animals. Nesczadimenko ('99) made peritoneal injections of yeasts in a physiological saline solution into rats, mice, guinea-pigs, and dogs, with death ensuing from eight to twelve days. He concluded, however, that these organisms were not so deadly, although causing this mortality.

The first actual case of blastomycosis, so-called, was reported by Gilchrist at the June, 1894, session of the American Dermatological Association. His paper resulted from the finding of peculiar yeast-like bodies in the diseased tissue of a patient. The doctor attending the patient had given the diagnosis as a typical case of chronic scrofuloderma. Several months after Gilchrist's report, Busse ('94) brought to light the extraordinary case to which he later gave the name "Saccharomycosis hominis." The patient was a woman thirty-one years of age who had suffered from a localized subperiosteal inflammation of the left tibia. An examination of the abscess, which opened spontaneously, revealed "numerous doubly contoured, very refractive, roundish and ovoid bodies," and these were found to be situated both intracellularly and extracellularly in the pus and abscess wall. These organisms when isolated in pure culture and then inoculated experimentally in animals proved to be what were later known to be blastomycetes. The patient later developed superficial ulcers on the face, subperiosteal swellings on the right ulna and the left sixth rib near the axillary line, with death ensuing. Busse cultured the yeast from the ulnar swellings and from the bottom of the ulcers.

Approximately two years later, the first case reported by Gilchrist was published in detail in the Johns Hopkins Hospital Reports of 1896. In the meantime, however, several others had noticed similar cases among guinea-pigs, horses, mice, and other lower animals (Sanfelice, '95, '96, '96a, Roncali, '95, Corselli and Frisco, '95, Tokishige, '96, and others).

In 1896, Curtis isolated a fungus similar to that described by the former writers from a myxomatous tumor of the leg. In the same year, Gilchrist, in conjunction with Stokes, published a short paper on a second case of blastomycosis, and this was published in detail two years later (Gilchrist and Stokes, '98). Simoni ('97), working on the diseased tonsils of patients, found budding yeast-like cells in twenty tonsils. Maffuci and Sirleo ('98) examined numerous tumors and found budding cells in a great number of tissues. Many other reports followed, as that of Hyde, Hektoen, and Bevan ('99) with a supplement by Hektoen ('99) later in the year, Hessler ('99) with a case report, and

several during the same year and 1900. In the following year appeared the elaborate work of Ricketts ('01), with a study of the organism from a case of systemic blastomycosis by Otis and Evans ('03). Eisendrath and Ormsby ('05) described a systemic infection, and Irons and Graham ('06) reported a severe generalized systemic disorder. Hektoen ('07) gave a comprehensive review of the literature, and from that time on the medical journals have published too great a number of cases of infection due to yeast-like organisms, under the heading of blastomycosis, to render a complete survey of literature a matter for a paper of this length.

ETIOLOGY AND CLINICAL MANIFESTATIONS

The disease known clinically as blastomycosis is very likely due to a plurality of organisms and not species of the same genus as indicated by previous writers. This is clearly evident as seen by the great number of papers published and the cases reported, involving such fungi as *Saccharomyces*, *Oidium*, *Monilia*, *Endomyces*, *Cryptococcus*, *Coccidioides*, and even such a form as *Sporotrichum*. The clinicians have referred to the category of blastomycosis any clinico-pathological condition which may be due to yeast-like or budding fungi. It must be understood, therefore, that the term as here used refers only to the clinical aspect of the condition.

In America, clinicians and medical men, more especially medical mycologists, are inclined to class as the cause of blastomycosis only that organism which was described originally by Gilchrist and Stokes in 1894 and in this view the author is greatly in accord. On the other hand, European workers consider only that organism which was reported by Busse ('94) and so elaborated on by Buschke ('98). However, by reason of priority, the organism of the former workers should hold the position so designated and be established as such. Further remarks on the Gilchrist organism will be found in the discussion.

Blastomycosis presents numerous clinical manifestations and in this respect it is protean, being found in practically every organ of the human body either in biopsy or autopsy material. No immunity towards the invading organism is established by any

of the anatomical structures. Clinically, the condition presents lesions which are alike both for the *cutaneous* type of the disease, that is that group of infections which may be found occurring superficially, or for the *systemic* type of the disorder, occurring in the lungs, bones, meninges, liver, or other viscera. This division is based on the work of Jacobson and his associates ('32), who further separate the cutaneous type into that of *primary* in character, as occurring in the epidermic layers or the cutis, as shown by Hagiwara ('22) and Hashimoto ('22), whose organisms, although not of the Gilchrist type yet coming under the general heading of blastomycosis as known clinically, also the work of Grschebin ('27); and *secondary*, due to an infection of the deeper tissues, internal viscera, or bony structures, as shown by Irons and Graham ('06), Ryerson ('09) for bones, and many others.

The *primary* form or the cutis infection Jacobson further designates as presenting one of three varied appearances: papulo-ulcerative; verrucous or papillomatous; gummatous.

The papulo-ulcerative type Jacobson designates as being initial lesions which are papulo-pustular in character and of epidermic origin (shown by Hessler, '99, Hektoen, '99, Ricketts, '01, Engelhardt, '24, and Fabry, '27, '28). These lesions rupture in the course of time and empty out the purulent exudate on the surface of the skin, with the probable ultimate formation of crusts. The process may be proliferative and involve a great area of the immediate vicinity. The lesions usually show a violaceous border with the involution of the peripheral surfaces and perhaps consequent scarring and atrophy.

The verrucous or papillomatous type (Froilano De Mello and Rodrigues, '29) is characterized as being nodular or papular in character and present on a normal or deep-red, infiltrated skin. Several of the lesions may coalesce to form papillomatous patches which resemble verrucous tuberculosis. These lesions may break up into healing areas which upon drying present irregular scars. The characteristic color as noted above is found here too, as well as the sloping periphery.

The gummatous type develops from the subcutaneous layers of the tissue of the deeper portion of the cutis in the form of small,

slightly elevated, somewhat tender, reddish, deep-seated, soft nodules situated on the characteristic violaceous-red surface of the skin. There is a diffusion of the color with subsequent establishment of new nodules in the vicinity. The nodules enlarge, become soft and gummatous, and then break down to form masses of ulcerative, proliferative materials bordered as in the other two types, and contain numerous abscesses.

The *secondary* cutaneous form consists chiefly of variously formed ulcers which give off a purulent or sanguino-purulent discharge from a soft, granulating floor. Some may develop crusts with raised edges, while some may assume hyperplastic functions with papillomatous characteristics, and usually there may be a metastatic action on the part of the ulcers represented by the formation of new lesions which are surrounded by a dark red or purplish zone. Healing may be spontaneous with indurated scars, as noted in some cases, or infection may persist but may finally succumb to treatment with iodides as was noted in the case reported here.

A study of the ulcers formed in blastomycosis shows them to originate in abscesses which from a clinical point of view can be divided into the superficial and the deep types. Secondary, cutaneous, superficial ulcers arise usually in the subcutaneous tissues as nodules of varying size as shown by Stober ('14), Engelhardt ('24), Ferguson ('28), and Montgomery and Ormsby ('08). These ulcers usually enlarge, rupture, and spread the material over the surface of the skin, setting up new foci, or in some cases they have been found to dry up and disappear.

The deep type of secondary cutaneous blastomycosis (Grschebin, '27, '28), characterized by smaller number and deep-seatedness, is by far the most serious of the two, involving destructive processes of the bone, muscle, and deep tissues and organs. It rarely shows any inflammatory reaction, but can be distinguished by the purulent character of the abscesses as contrasted with the mucoid or mucopurulent nature of the superficial abscesses.

The above types represent the typical forms occurring in a clinic. However, Weidman and Douglas ('21) reported the occurrence of a sarcoma-like tumor on the leg of a patient, which

looked like lupus vulgaris and yielded blastomycetoid bodies on histological sectioning. Then, about six years later, Cleland ('27) reported a case with the formation of a myxomatous-looking tumor mass which also showed typical cells on sectioning. These, however, are rare and until more cases are reported cannot be placed in the definite clinical types.

Under the heading of cutaneous blastomycosis, Castellani has also established principal types of blastomycosis of the cutis from a clinical point of view.

1. *Blastomycosis verrucosa* (Synonym: Blastomycosis, Gilchrist type).
Etiology: *Cryptococcus dermatitidis* Gilchrist and Stokes, 1896 (Synonym: *Cryptococcus gilchristi* Vuillemin).
Castellani here creates the genus *Blastomycoides.*
2. *Blastomycosis ulcerativa profunda seu mutilans* (Synonym: Blastomycosis, Wernicke-Ophüls type or Blastomycosis coccidioides type).
Etiology: *Coccidioides immitis* Rixford and Gilchrist, 1896.
3. *Blastomycosis purulenta profunda* (Synonym: Blastomycosis, Busse type; Blastomycosis subcutanea purulenta).
Etiology: *Cryptococcus hominis* Vuillemin, 1901 (probably covers many species).
4. *Blastomycosis glutealis* (Synonym: Blastomycosis, Kartulis type).
Etiology: mycological investigations not yet completed. The fungi seem to belong to the genera *Monilia* and *Cryptococcus.*
5. *Furunculosis blastomycetica cryptococcica* (Folliculitis decalvans cryptococcica, pro parte, Castellani type). (Synonyms: Furunculosis cryptococcica; Pseudofurunculosis blastomycetica; Furunculosis mycetica; Folliculitis decalvans saccharomycetica; Folliculitis decalvans moniliaca).
Etiology: yeast-like fungi either of genus *Cryptococcus* or *Monilia* (No asci or ascospores according to Castellani).

In addition to the above types, Castellani adds the following, although they are in no way connected with the blastomycosis organism: Blastomycosis epidermica; Intertrigo blastomycetica; Dermatitis blastomycetica interdigitalis.

For clinical purposes in diagnosing skin infections such a classification is good, but for correct determination of the etiological agent, it is essential that each type of involvement be named with the infective agent designated as such. For example, if the organism be a saccharomycete, the disease should be called *saccharomycosis;* if a monilia, then *moniliomycosis;* if an endomycete, then *endomycosis.* Thus, when the organism is correctly diagnosed the amount of time necessary to determine the right sort of curative measure for that type of infection may be taken, and the amount of time necessary for healing reduced.

SYSTEMIC BLASTOMYCOSIS

As mentioned previously, the disease is protean in its clinical manifestations, with the result that practically every organ in the body has been shown to be infected either in the living, by various measures, such as X-ray, or in autopsy material. No vital organ is immune, and this in itself is sufficient to cause a careful physician to give more attention to therapeutic measures. This universal infectivity of the agent was especially shown by such writers as Otis and Evans ('03), Eisendrath and Ormsby ('05), Le Count and Myers ('05), Irons and Graham ('06), Montgomery and Ormsby ('08), Wade and Bell ('16), Garr ('25), Panja ('25), Toepel ('29), and Maner and Hammack ('30). There is, however, a difference in frequency with which the various organs show their susceptibility.

The portion of the anatomy that shows the greatest amount of infection is the skin, either primary or secondary, having about 95 per cent of all cases recorded. This phase of blastomycosis has received the greatest amount of attention principally because it is so prevalent, but also because it is usually a manifestation of a metastasis from the deeper organs, and this helps bring forth the diagnosis of blastomycosis.

The pulmonary system, including the lungs and bronchi, constitutes the second most frequent and the most common systemic form, being present to the extent of approximately 95 per cent in systemic infection in available autopsy records, and about 35 per cent in primary cases. This was shown by such men as Stober ('14), Wade and Bell ('16), Wade ('18), Dennis ('18), Miller ('27), Medlar ('27), and Mazza and Niño ('28). The disease probably is primary in the bronchi and from there spreads to the lungs. If secondary in the lungs, as in systemic disorders, the process may be slow and chronic; if primary, however, the spread may be rapid and fatal.

The kidneys are next in frequency of infection. The genito-urinary involvement is usually secondary by way of metastatic foci through the blood. The disease in these organs manifests itself in the form of nephritis, showing casts and albumen in the urine. The culturability of the organism from samples, however,

cannot be demonstrated unless the kidneys are accompanied by infected bladder or prostates.

The spleen follows next in order, but this organ is usually easily susceptible so that a great amount of infection is to be expected in any systemic disorder of this sort.

The complication of the bones and joints seems next in the amount of infection. This form of the syndrome is very common in systemic disorders, and may even be a primary infection if the diagnosis in the patient here described was correct seven years previous to his entry at the Barnard Skin and Cancer Hospital. This type of the disease may manifest itself in the form of arthritis, osteitis, osteomyelitis, or periostitis, according to Ryerson ('08–'09) and Stober ('14). The process usually results in a suppuration, formation of sequestra, and abscesses which break down intervening cell walls and coalesce, causing great damage.

The liver appears to be a rather frequent subject to the infection, coming next in the order of frequency. This is to be expected in systemic disorders where the blood plays an important part. Metastases through the blood vessels are fairly common, and yeast cells are easily transported to the main organs in this manner.

The pleura too are susceptible to a great extent, and here the proximity to the lungs is a great factor in their infection.

The lymph glands follow along rather closely, as shown by Wanamaker ('28), especially for the cervical lymph glands.

Cerebrospinal involvement, including the brain, meninges, spinal cord, and skull bones, occurs fairly often as a secondary metastatic process in generalized systemic blastomycosis, according to studies made (J. T. Moore, '20, Freeman and Weidman, '23, Greenfield, '24, Wilhelmj, '25, and Gáspár, '29), being found in at least 12 per cent of the cases. When the disease is secondary to a general systemic infection, there may be osteomyelitis of the skull bones with destructive processes. The diagnosis rests not upon any clinical entities which may be present, because the inflammatory reaction simulates many other conditions, but upon the actual laboratory finding of the organism either in the spinal fluid or in sections of the diseased brain tissue.

Wilhelmj ('25) states that in those cases where there is no pathological symptomatology or clinical manifestation on any other part of the body, and when the meninges are infected during the primary stages of the invasion, death may occur without the initial appearance of general metastatic foci, and such a condition he calls primary cerebrospinal blastomycosis. The spine may be involved in the process in a suppurating condition (Parker, '23), but this condition is relatively rare.

Jacobson lists the vertebrae as being next to the brain in susceptibility to attack. This condition has been noted on several occasions. Roentgenographic studies usually reveal an infection of bodies of the vertebrae, and lamina and posterior ligaments may show an involvement which simulates greatly tuberculous Pott's disease.

Prostatic infection in blastomycosis is often noticed (Parmenter and Simpson, '19). Usually it is associated with a genito-urinary complication and involves the urinary bladder (Rhamy, '26). In these cases acute urinary urgency and pyuria are well-defined symptoms.

The heart lesions in blastomycosis are shown first in the pericardium and then in the myocardium in the form of an inflammatory reaction (Hurley, '16).

Pancreatic involvement follows in frequency.

Infection in the peritoneum is the next most common. Jacobson reports finding the disease in the abdominal viscera in the following decreasing order of frequency: kidneys, spleen, liver, lymph glands, pancreas, peritoneum, adrenals, and gastro-intestinal tract. These organs, as pointed out previously, become involved usually through metastasis by way of the blood stream or by direct transmission from tissue to tissue. In this manner, testicular blastomycosis is usually developed. Blanchard, Swartz and Binot ('03), as early as 1903, noted an intraperitoneal involvement.

The eyes may also be involved. The infection here is very painful and often dangerous, leading to blindness with perhaps a complication of the nervous system and the brain. McKee ('26) and Ferguson ('28) noted cases of the eye which were secondary infections due to a metastasis from the pulmonary apparatus.

Laryngeal and tracheal blastomycosis are rare infections. Jacobson records four in America and one in Europe. All the patients were adult males working either with the soil or its products, one being a clerk in a general store (Dennis,' 18, Downing, '18, C. Jackson, '26, and New, '28). The larynx showed a "chronic inflammatory mucosa with a grayish, minutely nodular surface in some portion of the lesion, with a few minute, isolated, yellowish nodules." There was often a reddish, raw portion of the larynx due to the ease with which the superficial layers came off with coughing. The process resembled very closely tuberculosis.

Involvement of the tongue is perhaps a rare occurrence, but cases are not reported in great numbers purely because sputa smears usually show a variety of yeasts and thus no definite etiological significance is attached to those obtained. The first case was reported by Copelli ('13), a second one by New ('17) from the Mayo Clinic. Since that time, however, Mazza and Canevari ('29) reported a case from Argentina, and Niño ('29) reported an infection of the lower lip with the involvement of the tongue. Such an infection usually hinders respiration, inasmuch as a tumor-like growth, as evidenced by Copelli and New, developed which enlarged in the back portion of the tongue and practically filled the entire larynx.

Symptomatology

Blastomycosis when of the primary cutaneous type presents no clinical symptomatology of discomfort or pain except for that expressed because of the lesions. When of the systemic type, however, the condition is very different. There are numerous clinical factors to make a picture which might easily be confused with a number of diseases.

According to numerous investigators, the onset of the disease varies with the person and amount of infection. It may be intense and acute, leading to death in a short time, or insidious and mild, with a prolonged chronic condition, death finally occurring as a result of a secondary complication. There is a typical set of symptoms once the disease is well established. This consists of typical malaise, recurrent chills, loss of weight,

as evidenced in the present case, loss of strength leading to general emaciation, night sweats, although morning sweats may be present too, irregular fever, pain in affected parts, and a rapid pulse.

The disease, as noted before, may be primary in the skin with subsequent spread systemically or it may be systemic with the formation in the later stages of nodular growths on the skin. Unless the patient is well taken care of, systemic infection results, leading ultimately to death.

DIFFERENTIAL DIAGNOSIS

The final diagnosis of blastomycosis rests on the finding of the organism either culturally in a lesion of the patient or, if that be unavailable as in systemic disorders, the identification of the fungus in biopsy or autopsy material.

As pointed out previously, the disease is protean in character, with the result that a careful examination must be made to diagnose it blastomycosis, comparing it with the several well-known clinico-pathological entities which it may simulate. The most noteworthy of these complicating diseases are as follows: (a) The dermic lesions described previously, developing necrotic and papillomatous growths or ulcers, resemble very closely epitheliomas, differing only in the rapidity of evolution and the absence of deep induration, verrucas, tuberculosis in its various forms, and syphilis. Its resemblance to sporotrichosis (Lewis, '17) has often been noted, but it differs in being less sluggish. It differs from syphilis only by the softness of the lesions, the reddish-blue ring around the lesion, and by a negative Wassermann, with, of course, the presence of the organism in the blastomycosis infection; (b) The systemic infections of blastomycosis must be distinguished through laboratory methods from a great many complications, particularly coccidioidal granuloma described in a previous paper by the author (M. Moore, '32). The organism of coccidioidal granuloma, *Coccidioides immitis*, reproduces by endosporulation, and the blastomycosis organism, through budding. Furthermore, the lesions in the so-called "California disease" are more rapid in evolution than in blastomycosis; (c) Infection of the glands which is quite rare in blastomycosis often suggests

lymphatic leukemia, Hodgkin's disease, and possibly lymphosarcoma; (d) Gastro-intestinal lesions may often resemble typhoid and in some cases the isolation of the organism is necessary to rule out this disease; (e) Osseous infection quite often resembles tuberculosis, particularly as reported by Ryerson ('08–'09); (f) Pulmonary blastomycosis very often presents the same clinical, histological, and pathological pictures as tuberculosis, as noted by Medlar ('27) and Miller ('27); (g) Infections of the brain often confuse the pathologist or clinician with its similarity to torula (Freeman and Weidman, '23), epidemic meningitis, and even tumors of the spinal cord; (h) Sutejew, Utenkow, and Zeitlin ('29) find that the use of bromides and iodides evidently causes an allergy which in its reactions presents lesions similar to those caused by the infective agent of blastomycosis and is often confused with it, the latter differing in their more rapid evolution.

It would seem, therefore, that the recognition of blastomycosis is not a very easy matter. The really important fact concerned with this work is to find the organism, which usually requires laboratory technique, and to verify its pathogenicity by animal inoculation in order to comply with Koch's postulates.

Predisposing factors.—The infective agent shows no particular preference as to sex, although more cases have been males than females, of the industrial classes, chiefly the workers of the soil and its products, a fact well exemplified in the present case. There is no discrimination as to race or color, all peoples being affected in like fashion. Stober ('14) correlates the type and amount of infection with the habitat and environment of the patient. As far as is known, all ages are susceptible, a similar condition existing for many other fungi which tend to become systemic, such as coccidioidal granuloma.

Treatment.—The successful therapeutic measures in blastomycosis are few and limited. The best treatment or cure for the disease rests of course on the skill of the physician in detecting it at an early stage before it has seized a definite foothold, when it can be kept from becoming systemic. If the disease is definitely located in a particular section, surgery may be used to eliminate it, as suggested by several authors (Wade and Bell, '16, R. H.

Jackson, '26). Cautery has also been used with beneficial results. Hedge ('28) has employed carbon dioxide snow in freezing cutaneous lesions with measurable success. X-ray treatment has also been used frequently, being combined with the administration of iodides. On the whole, primary cutaneous lesions yield fairly readily to iodides and even the application of crystal violet and gentian violet, although their use if at all successful is empirical because dye therapy does not rest on any scientific basis (Spring, '29).

In systemic infections, however, one has to contend with complications. The extent of the infection cannot be determined easily. The only cases to recover from an infection of this sort are those to which special care and attention coupled with a change to a clean, pure atmosphere had been made, with the administration of large amounts of saturated iodide solution, either potassium or sodium, although the former has been used more extensively. The dyes mentioned above have proven worthless to the systemic type of disorder. Several workers have advocated copper sulphate, but many others have found this to be useless. Roentgenotherapy has, as yet, no really therapeutic importance. Stober has applied immuno-therapy in the form of a vaccine of suspended blastomycotic cells, heated to 110° C., but no definite results can be shown.

It would seem, therefore, that therapeusis is greatly in need of investigation.

Immunological reactions.—Immunology in blastomycosis has not reached any definite point as yet. Agglutinins have been reported by some, and negative results by others. Precipitins have also had the same reaction, as well as complement fixation. On the whole, results are indefinite and a good deal more information is needed. The main difficulty seems to be that the toxins of the blastomycosis fungus are difficult to demonstrate. So far, immunology is an open book with only attempts proving nothing written on its pages, and it is to be hoped that more work can be done along this line for the benefit of those who may be inflicted with this syndrome-complex.

Mortality.—The number of deaths resulting from blastomycosis is a factor worthy of note, since systemic disorders due to the

typical blastomycotic organism usually prove fatal. This is so because systemic infections are rarely diagnosed as such until there have been cutaneous outbreaks, with the result that therapeutic measures are given too late for beneficial results. It is difficult to quote figures because there are many cases occurring which have rapid recovery and the physician does not report them. Moreover, true blastomycosis is difficult to diagnose unless smears and cultures are made from the abscesses. In many instances, several attempts are necessary before any fungous growth is obtained, and unless the investigator is well trained in mycological technique and in the recognition of such forms typical of the Gilchrist organism the application of Koch's postulates would be essential, particularly with mice and guinea-pigs.

Report of Case

Clinical History.—M. H. L. (Hospital No. 50095), a white, widowed male, farmer by occupation, 43 years of age entered the Barnard Free Skin and Cancer Hospital, at Saint Louis, Missouri, April 5, 1932, with an ulcerating, proliferating infection of the left hand and forearm, which the patient claims to have had for 5 years.

Family History.—Father died as a result of high blood pressure, hypertension, at age of 56 years. Mother dead due to throat trouble, at age of 30 years. Three brothers and one sister dead due to an infancy cause. Patient has 7 children, all living and well. Wife dead due to double pneumonia at age of 38 years. No history of diabetes, nephritis, syphilis, or cancer in family.

Past History.—Past health has been good; usual childhood diseases. He had pneumonia at 15 years of age, bronchial pneumonia at 18 years of age, and influenza in 1918. He has had no operations other than those to be mentioned in the present illness. Right leg injured 7 years ago.

Personal History.—Patient denied any venereal disease.

Present Illness.—Patient stated that 7 years previously, a limb had fallen on his right lower leg, causing a knot to form. The physician who examined his leg thought he had a periostitis and opened the lesion on the leg. About 2 years later, or 5 years previous to entering the hospital, a mossy, verrucous-like lesion similar to that on the leg appeared on the back of the left hand. Both the lesions on the right lower leg and on the hand continued to spread. The patient went to the Vanderbilt University Hospital, at Nashville, Tennessee, about a year later, at which time the eruption had spread over most of the anterior and lateral sides of the right lower leg with two lesions of the right thigh above the right knee and with involvement with most of the back of the left hand and part of the forearm. He remained in the Vanderbilt Hospital for about 3 months, during which time the lesions on the right leg and arm were curetted and treated with X-ray. At the time of his discharge, the lesions on his right leg had healed, as had most of the hand except that portion near the thumb and the wrist. Another currettement was performed, but the lesion persisted. He received two X-ray treatments each on the leg, arm, and hand. Six years previous to entering the Barnard, he had lesions on the right elbow region;

these lesions healed. About 4 to 6 years before his entry he had lost some weight, but at the present time complains of no recent loss of weight. He gives no history of hemaptysis, night sweats, fever, or frequent colds. About 10 days previous to entry, a reddish lump developed on the flexor surface of the left lower arm near the elbow. This lump is not very tender or painful. He has been applying potash on the ulcerated area of the left hand.

Physical Examination.—Patient is a thin, coöperative, moderately active, white male 43 years of age, who has had the condition herein to be described as blastomycosis of the left arm and hand for approximately 6 years and who had the same condition on the leg for 3 years until it was curetted and X-rayed 4 years previously. The right leg and left arm show scarring which will be described later.

Head.—Normal size and shape.

Eyes.—Eyes react to light and accommodation. Reactions normal.

Ears.—No discharge, apparently normal.

Nose.—Septum intact, no ulcers.

Throat.—Slight redness.

Mouth.—Several teeth missing.

Neck.—No stiffness or rigidity; tonsillar and cervical glands palpable.

Thorax.—Thorax hairy, thin, and symmetrical; expansion fair.

Lungs.—Breath sounds a little harsh and rough over both lungs, principally the right and right apex. Voice sounds normal, but louder on the right than on the left. No persistent or moist râles or râles heard after coughing. Expansion and resonance normal.

Cardiac.—Cardiac sounds a little slow and distant, but of a normal quality. No enlargement or pathological murmur. Blood pressure, 106 systolic and 66 diastolic.

Abdomen.—No masses or tenderness. Inguinal glands a little enlarged.

Genitalia.—Normal male; no discharge or penile sores.

Reflexes.—Superficial—present and active. Babinski negative. Deep—present and active.

Extremities.—Left arm and hand—The lower third of the left forearm, back of the hand and extending 2 or 3 cm. on to the palm, is involved in an atrophic process sharply defined superiorly and inferiorly with some scaling, no telangiectasis. On the external surface of the forearm extending on to adjoining parts of the hand and thumb is an ulcerative process which has been covered with a black crust. Ulcerated area of the left thumb and the flexor surface of the left forearm consists of warty-like and cone-like, multiple abscesses with some elevation of the borders. There is a deep scar on the right elbow region. The anterior, medial, and lateral aspects of the right lower leg are covered with a thin, smooth scar about 12 to 14 inches long and covering two-thirds of the right lower leg. There are two scars just above the right knee, about 4 inches, and 8×4 inches in diameter, respectively.

On the flexor surface of the left forearm, just below the elbow, is an abscess which is red in color, oval in shape, semifluctuant, practically non-tender and not hot. Extending up from and about the abscess is a chin of firm lymph nodes. The lymph nodes above the left elbow and epitrochlear region are a little enlarged.

Laboratory Findings.—Urine negative, being pale straw in color and clear. Blood tests showed 4,600,000 red blood cells and 10,200 white blood cells, with 84 per cent hemoglobin. The differential blood count showed 26 lymphocytes, 8 large mononuclears and transitionals, 156 polynuclear neutrophiles, 2 polymorphonuclear eosinophiles, and 2 basophiles. Wassermann negative. Smears from the left hand and

arm showed budding forms of yeast cells on April 7, 1932. Blood, urine, and pus from left hand and lower arm and pus withdrawn from abscess of left arm were inoculated on glucose-glycerine agar on April 8. Spinal puncture on April 12 showed a clear fluid with a normal pressure. Glucose-glycerine agar and blood agar were inoculated with spinal fluid, with no growth occurring.

April 9, 1932.—The patient was started on potassium iodide with dosage up till signs of intoxication, and an ointment saturated with gentian violet was applied locally. This treatment was followed with 10 per cent sodium iodide intravenously for several days when patient showed an improvement.

April 16, 1932.—X-ray of left forearm and wrist, right femur, and right leg showed no abnormal bone changes. The hilar and bronchial structures of both lungs showed considerable thickening, inflammatory in character, but the parenchymatous portion of both lungs appeared free from any active pathology.

July 7, 1932.—Patient showed a very marked improvement, with still some evidence of trouble around the left thumb.

Clinical Diagnosis.—Blastomycosis of left hand and arm.

The agar inoculated from the left arm developed a culture which went through the three stages typical of the organism of blastomycosis: the yeast-like growth; the prickly type of growth; and the cottony type of growth. This culture was used for the studies carried out in this paper.

Animal Inoculation

A suspension of a 10-day-old culture of the organism in sterile saline was inoculated in a mouse, intratesticularly. An orchitis developed and the mouse showed typical malaise, emaciation, loss of appetite, loss of weight, rise in temperature, with death ensuing in three weeks. The internal viscera showed numerous, pin-point lesions at autopsy, which when squeezed exuded a muco-purulent material from which the yeast cells were isolated. This was in accordance with Koch's postulates.

Technique

In order to ascertain the morphological characteristics of the fungus, the organism was suspended in hanging-drop cultures, allowed to grow, and observations made from time to time. For finer detail and structure, several transfers were made to slides on which had been placed a drop of a mixture of glycerine (Merck C. P.) and a 1 per cent solution of crystal violet. The fungus was allowed to remain for a period of one-half to one hour to allow for a clearing of the material and sufficient staining to render satisfactory results. This method proved adequate for the work here described. Another method was used also, whereby material was fixed on a slide smeared with albumin and then stained with

methylene blue and eosine. The first method, however, was sufficient.

DESCRIPTION

A study of the organism in lesions reveals a yeast-like growth of spherical or ovoid, budding and branching cells with no evidence of any filamentous hyphae. These cells, measuring approximately 7–12 μ in diameter and sometimes as much as 20 μ in length, may occur singly, in groups of two's, three's or four's, as individual colonies. On closer examination microscopically, these yeast-like cells (pl. 6, figs. 1–9) show a heavy, reticulated, granular, and in many cases, vacuolated, protoplasm, and a very definite nucleus with emanating streams of cytoplasm. In many cells the nucleus is barely distinguishable, being a mass of cytoplasmic structures, but further study after several subcultures shows up this part of the cell very frequently. Many of the yeasts of this group may show a double-contoured, highly refractile membrane, and this feature is of little diagnostic use unless demonstrated in tissue sections, as by Rewbridge, Dodge, and Ayers ('29) for *Endomyces capsulatus*, and by Moore (McBride and Thompson, '33) for *E. capsulatus* var. *isabellinus*. Thus Wade ('16) ascribes to the fungus structure in tissues: (1) an inner delicate *capsula vera;* and (2) an outer applied *capsula sclerotica*. In any case, the capsule is lost on repeated cultivation on artificial media.

With agar as a substrate, the yeast-like cells elongate (pl. 6, figs. 10–12, 14–17) and on acid media become thin-walled and long with a diameter of 2–2½ μ. These hyphae become intertwined and are composed chiefly of isodiametric cells. On neutral or slightly alkaline media, with protein as the chief source of nitrogen, the hyphae are thicker and shorter, with a diameter of 3–4 μ. This condition is especially true of media with an excess of carbohydrate as found in glycerine agar.

Budding cells are numerous on slightly acid media, being about 5 μ in diameter (pl. 6, figs. 26 and 28).

The hyphae, at first clear, become granular, and at various points along the sides develop numerous small, knob-like projections of the limiting membrane, which enlarge, round out or become pyriform and sessile, measure approximately 5 μ in

diameter, and occur usually near a septum. These are known as conidia and may remain attached, at times to small stems or sterigmata, or may become free and develop in the media by budding (pl. 6, figs. 24, 26, 28–29).

Racquet mycelium (pl. 6, figs. 23–24), a phenomenon characteristic of the fungi of this group and especially of the Trichophytons and various other Ascomycetes, is common here, having the swollen portion 5–6 μ in diameter and the narrow section 3–3½ μ in diameter. Chlamydospores may be found arising in the hyphae or terminal as hypnospores, varying in size and shape from round cells 7–8½ μ in diameter, to elongated, widened cells 5½–7½ μ wide and 12–15 μ long (pl. 6, figs. 22, 25, 27–29, 31, 32, and 37), or they may arise as sessile cells from the hyphae (pl. 6, fig. 36). Round, thick cells with a coarse, granular cytoplasm are particularly evident on cornmeal agar (pl. 6, figs. 26 and 28).

When first examined in a hanging-drop preparation, one may see oil droplets on the hyphae which are strongly suggestive of endospores. These disappear, however, when the organism is stained. In some cases, as in pl. 6, fig. 25, a hollow sphere or vacuole surrounded by a hyaline, gelatinous substance may be present in the filament.

The development in tissue, as has been noted, is chiefly by budding or gemmation. The process begins with the projection of the inner layer of the cell or endosporium, following Hektoen, which pushes the transparent zone and outer membrane in front of it. The bud becomes enlarged and surrounded by the same walls as surround the mother cell, and division takes place by the presence of a cross-wall which is formed by the pinching in of the cell (pl. 6, figs. 1–3, 6–7). On artificial media, on the other hand, proliferation of the fungus is brought about through sexual reproduction which is heterogamous. Two terminal cells may fuse (pl. 6, fig. 19) or two hyphae growing side by side may send out lateral cells which copulate (pl. 6, fig. 18). In either case, a spherical ascus results which may be terminal on a long filament or lateral on a short peduncle (pl. 6, fig. 33) and has a thick capsule (pl. 6, figs. 21 and 33), sometimes surrounded by a sheath as in pl. 6, fig. 35. The latter case, however, is rare and was

observed only three times. There are formed 8 spherical to ovoid, smooth spores which are hyaline when young and held in a gelatinous substance and when older become chamois-colored and granular, and have at maturity a diameter of 2–3 μ, varying on different media (pl. 6, figs. 38 and 33).

This organism therefore agrees with that described by Gilchrist and Stokes as *Blastomyces dermatitidis*, but further observation has here been made on the sexual development.

CULTURAL DESCRIPTIONS

The culture in this case was growing on glucose-glycerine agar, being an inoculum from an abscess on the left arm. All cultures used in the cultural determinations were taken from the above tube and grown at room temperature, approximately 22° C.

Having the two stages so common with yeast-like organisms and characteristic of several members of the Endomycetales, it was thought desirable to transfer the fungus on a wide variety of media and pH range. Possessed with saccharomycetous properties, on the one hand, and filamentous fungous affinities, on the other, the above method of culturing proved to be satisfactory in this work.

The following media used are arranged in the order of decreasing hydrogen-ion concentration.

Raulin's Solution (*pH 4.1*).—Culture shows a thin, smooth suspension of yeast-like cells, budding and branching, varying in size from 4½–5½ μ x 7–8½ μ, with several showing a change to filamentous formation.

Richards' Solution Agar (*Media consisting of Richards' solution with the addition of 1.5 per cent agar. pH 4.4*).—Growth sparse, of fine filaments. Colony 3½ cm. in diameter at end of 30 days. Culture shows long hyphae projecting from edge of growth, 2½–3 μ in diameter, with numerous budding cells. Filaments branching, with cross-walls, numerous chlamydospores, and swellings. Characteristics of the group present. Color of colony isabella to cinnamon, strongly suggestive of chamois, due to the spores and asci which are in abundance.

Czapek's Agar (*pH 4.4*).—Color of colony white, becoming chamois with age. Growth very sparse and cottony, with much

of the mycelium submerged in the agar. Colony 4 cm. in diameter at end of 24 days. Hyphae long and thin, 1½–2 μ in diameter, with swellings approximately 4 x 12 μ, several thick-walled chlamydospores 7½ x 14 μ, and numerous terminal hypnospores. Several 8-spored asci seen, as well as many conidia.

Malt Extract Agar (*pH 5.3*).—Growth slow and cultural characteristics insufficiently different to be taken into discussion.

Sabouraud's Agar (*pH 5.6*).— Growth rapid, profuse, obtaining a diameter of 7½ cm. at end of 30 days. Culturally the colony simulates very much that of *Microsporon audouini* of Ota and Langeron in the presence of several radiating ridges from the round center, the inoculum, and the several concentric rings of growth of decreasing abundance, just outside the ridges. Color of colony white when young and becoming the characteristic chamois when older. Like *M. audouini*, it has racquet mycelium, chains of round cells on a hypha measuring 3½ μ in diameter, numerous chlamydospores 8 x 12 μ, terminal hypnospores 5 x 11 μ, and many conidia, characters found also in the Trichophytons and peculiar to *Endomyces capsulatus*. Unlike *M. audouini*, however, this organism reproduces by the formation of asci which are numerous here, measuring from 10 to 13 μ in diameter, containing 8 spores.

Sabouraud's Broth (*Sabouraud's medium minus the agar. pH 5.6*).—Culture consists of submerged mycelium of large flakes, each measuring approximately 2 cm. in diameter at end of 24 days. Mycelium floating on surface, dry, and chamois colored, with white region, presumably the young hyphal elements. In general, growth is good. Microscopically, the culture shows long, narrow hyphae 2½ μ in diameter, branching and intertwining. Submerged mycelium shows almost no swellings, chlamydospores, terminal hypnospores, nor thick-walled cells, as compared with the great number found in that on the surface. The several that are present, however, show a great reduction in size and form from the exposed, the measurements of which are similar to those on agar.

Potato-dextrose Agar (*pH 5.6*).—Growth profuse and cottony, covering the surface of the agar completely. Diameter of colony

7½ cm. after 24 days. Color cinnamon, with colony showing concentric circles of color alternating with white, and the cinnamon very pronounced, due perhaps to the medium constituents. Hyphae 3 μ in diameter, with numerous, thick-walled cells 7½ μ in diameter, budding cells, swellings 5 x 12 μ, and chlamydospores varying in size from 4–7 x 9–14 μ. Asci numerous, measuring approximately 13 μ in diameter.

Corn-meal Agar (*product of Digestive Ferments Co. pH 6.0*).—Growth poor, colony being 1½ cm. in diameter at end of 24 days. Color white. Growth around inoculum loose and cottony. Hyphae short, thick-walled, 2½ μ in diameter, with numerous budding cells approximately 7 μ in diameter. Chlamydospores numerous, 7 x 13 μ, terminal hypnospores several, 5 x 12 μ; a few asci seen, 11 μ in diameter. Conidia abundant, 5 μ in diameter.

June-beetle Agar (*medium consisting of a 4 per cent extract of June beetles, Lachnosterna fusca, plus 1.5 per cent agar, sterilized at 20 pounds pressure for 20 minutes, with a final pH 6.1*).—Growth of loose, flat, cottony mycelium, forming concentric circles of decreasing abundance until a ring of fine filaments surrounds the culture. Colony 5½ cm. in diameter at end of 24 days. Hyphae 2–2½ μ in diameter, with many conidia 5 μ in diameter. Asci 12–13 μ in diameter, thick-walled, enclosed in a sheath. Abundance of racquet mycelium.

June-beetle Dextrose Agar (*above medium plus 2 per cent dextrose*).—Growth fair, attaining a diameter of 3 cm. at end of 30 days. Colony bright chamois in color, cerebriform, and cottony. Many conidia, 4½–5 μ in diameter. Hyphae 2½–3 μ in diameter and fairly short. Chlamydospores 8 x 16 μ and numerous, as well as terminal hypnospores 5 x 12 μ. Asci round, 12–14 μ in diameter.

Lactose Agar (*product of Digestive Ferments Co., lactose broth plus 1.5 per cent agar. pH 6.8*).—Growth good, reaching a diameter of 6 cm. at end of 24 days. Colony chamois-color, profuse and cottony, with a region of very fine mycelium surrounding it. Hyphae 3½ μ in diameter with numerous conidia 5 μ in diameter, budding off. Many thick-walled resting cells 7 μ in diameter. Characteristic racquet mycelium, chlamydospores, terminal hypnospores, with properties similar to those on Sabouraud's agar.

Lactose Broth (*product of Digestive Ferments Co. pH 6.8*).—Growth good, large white flakes being formed in the solution which later become intertwined, forming a mat of mycelium 7 μ in diameter. Hyphae slightly reduced, 3 μ in diameter, 1½ μ in the younger filaments. Preponderance of budding cells 7 μ in diameter, with thick-walled chlamydospores, asci, and terminal hypnospores, but reduced in size as compared with the growth on agar.

Eosine-methylene-blue Agar (*agar used as one of a routine, product of Digestive Ferments Co. pH 7.0*).—Growth good, with a diameter of 5½ cm. at end of 24 days. Culture compact, due to the hyphae having absorbed the stain from the substrate and turning the mycelium pink. Colony appears powdery with age. Hyphae characteristic, with swellings, 3 μ in diameter. Many conidia, 5 μ in diameter, and hypnospores with several chlamydospores.

Glycerine Agar (*nutrient agar as prepared by the Digestive Ferments Co. plus 6 per cent glycerine, Merck C. P. pH 7.1*).—Growth fair, having a diameter of 5 cm. at end of 24 days. Culture shows a crinkled, moist region of budding yeast-like cells and a dry filamentous, cottony, chamois-colored region which has changed to the mycelial form characteristic on agar. Filamentous hyphae 3½ μ in diameter, characteristic swellings being present which are slightly larger than those found on lactose agar. Racquet mycelium also present.

Nutrient Agar (*product of Digestive Ferments Co. pH 7.2*).—Growth rapid, covering a region 7 cm. in diameter at end of 30 days. Colony filamentous, cottony, brown, with concentric rings of growth, the outermost being white. Hyphae 2½ μ in diameter. Growth similar to that on Sabouraud's agar microscopically, with numerous conidia 5 μ in diameter and asci 13 μ in diameter.

Nutrient Broth (*pH 7.2*).—Culture forms a mat of intertwining mycelium of long hyphae 2–2½ μ in diameter, with swellings, asci, and chlamydospores. Very few conidia. Terminal hypnospores several, but reduced in size, 4 x 9 μ.

Endo's Agar (*product of Digestive Ferments Co. pH 7.5*).—Growth fair, colony having a diameter of 3½ cm. at end of 30

days. Culture shows radiating ridges from center of inoculum, with growth becoming flat due to the stain in the medium which is absorbed by the hyphae, as in the case of the eosine-methylene-blue agar, giving the mycelium a pink color. Microscopically, the hyphae have a diameter of 2½ μ. Numerous conidia 5 μ in diameter. Culture otherwise similar to that on eosine-methylene-blue agar.

Gelatine (*nutrient agar plus 1.5 per cent gelatine*).—Slow liquefaction beginning after 30 days.

Culturally, the fungus is very characteristic of the organism of blastomycosis in that it passes through the three typical stages: the moist, yeast-like stage with a flat growth; the prickly culture with the colonies simulating greatly small burrs (coremia); and the final, cottony growth present on agar after extended growth.

DISCUSSION

As stated in the introduction of this paper, it would seem that the syndrome-complex, commonly known as blastomycosis, has an innumerable list of etiological factors, each causing a condition so much like the other that clinicians have grouped them under one head. However, should one encounter any of these in a clinic one would find that therapeutic measures are so vastly different, varying with the organism, that a direct and accurate knowledge of the causative agent in each particular patient is absolutely essential.

In the past, medical men, not particularly trained in mycological taxonomy, were inclined to class together all fungi presenting ascomycetous characters under one name, *Blastomyces*. So great is the confusion to-day that it is necessary to pick out these pathogenic fungi and classify each one separately.

The organism isolated in the first case was termed *Blastomyces dermatitidis* by Gilchrist in 1894 because of its budding properties in the lesion. In a case of dermatitis reported by Gilchrist and Stokes ('96) the organism, which was evidently of the type termed *Blastomyces*, was called an *Oidium*. In a following paper (Gilchrist and Stokes, '98), it was made known that the organism described in the previous paper was called an *Oidium* because it did not ferment glucose, saccharose, or lactose, and although

developing by gemmation or budding in the tissues, human and animal, developed mycelia with the formation of conidia upon artificial media. Ricketts ('01) made an extensive study of the organism, distinguishing it from several of the yeasts but failing to consider several of the yeast-like fungi, and proposed definitely the name *Oidium* for the genus of the Gilchrist fungus. After this work, several terms were applied to the disease. Busse ('94) described his case a short time after Gilchrist reported his and he named the organism *Saccharomyces hominis*. Vuillemin in a later publication assigned the organism to the genus *Cryptococcus* and called it *C. gilchristi*. However, he failed to make a careful study of the organism culturally on artificial media, and a classification which places a great emphasis on the yeast-like appearance of the fungus in lesions is not exactly justifiable. Brumpt ('27) places the organism in the genus *Mycoderma*, calling it *M. dermatitis*. This terminology, however, is synonymous with *Oidium*, and in that case is likewise useless.

For a great number of years, no great work was done to establish definitely the position of Gilchrist's organism, and the name *Blastomyces* as created by him still held sway. The term presents a lot of difficulties. In the first place, the Blastomycetes, according to Buschke, are that group which develops through budding, provided a mycelium is formed on agar, while to the group of Blastomycetes, as Naegeli names budding, would belong the genera *Endomyces*, *Saccharomyces*, *Cryptococcus*, *Monilia*, and *Oidium*. Now the question arises as to what the actual meaning of the word blastomycete is. According to Vuillemin ('01), it does not designate a natural group, a botanical family based on genealogical affinities. There is in existence a genus *Blastomyces*, but these organisms are not budding fungi in the sense of Buschke. They are filamentous fungi whose spore-bearing elements, whether terminal, lateral, or intercalary, can be isolated by disarticulation, following Costantin and Rolland (quoted by Vuillemin). Frank (quoted by Vuillemin) established the Blastomycetes as an order to include such fungi as the beer yeasts whose elements are isolated by budding and not by disarticulation. In this respect, by virtue of the law of priority, it would seem that the name Blastomycetes, as designated by Frank, should remain. However,

if by general agreement the name of a genus could replace that of an order, then, according to the rules of nomenclature, the genus of Costantin and Rolland is legal, and the name as designated here is not legitimate by reason of the lack of distinct characters which have no generic value.

Castellani recently proposed a new classification of yeast-like or budding fungi based on the presence or absence of ascospores, which includes families of both the Ascomycetes and Fungi Imperfecti.

1. Saccharomycetaceae: budding cells, asci, and ascospores, but no mycelium in culture.

2. Endomycetaceae: budding cells, asci, and ascospores, with mycelium in culture.

3. Cryptococcaceae: budding cells (blastospores), no asci and no mycelium in culture.

4. Oosporaceae: budding cells, no asci, but mycelium in culture.

In addition to this family classification, he created a new genus which he calls *Blastomycoides*, to which he assigns three species, and places it in the family Oosporaceae: 1. *Blastomycoides dermatitidis*, synonym *Blastomyces dermatitidis* Gilchrist and Stokes; 2. *Blastomycoides immitis*, synonym *Coccidioides immitis* Rixford and Gilchrist; 3. *Blastomycoides tulanensis* Castellani. He defines the genus *Blastomycoides* as: "Oosporaceae appearing in the lesions as large roundish cells from eight to twenty microns in diameter, or larger, with the protoplasm containing a number of well-marked granules or spherules, and with a membrane showing a well-defined double contour; in dextrose agar cultures a large amount of mycelium is present." He bases further differentiation of the three species on their cultural differences when grown on mannitol, lactose, glucose, and galactose agar.

The second species that he names, *Blastomycoides immitis*, has already been discussed and classified by the author in a previous paper (M. Moore, '32). The author has made no pretext of studying the third species, so that nothing can be said about that. The first species, however, *Blastomycoides dermatitidis*, is altogether misplaced, simply because there are asci present in the mycelium in culture. This of course would refer the genus to the family Endomycetaceae, in which group the writer definitely establishes the organism.

Observations on the growth, development, reproduction, and further evolution of the fungus show that there are budding cells in the lesions, mycelium formed on agar with an intermediate stage showing the change from the yeast-like to the filamentous form. In accordance with this, Mellon ('24, '26, '26a) has recorded the fact that asci do occur particularly "in the so-called secondary colonies of the cultures which also contained 'dauernzellen' and pigmented oidia." The author wishes to affirm Mellon's findings as to the presence of asci, but suggests that these structures are present in the third stage, whereas the second step would consist of the intermediary forms which have an appearance very much like greatly enlarged oidia. Furthermore, it would seem that Mellon's description was indefinite, inasmuch as he refers to an ascus as an ascospore, and oil droplets are suggested by him as being chromatin indicators and forerunners of the future spores. Such factors as these are very important in the taxonomy of this type of fungi and should not be dealt with so promiscuously. Furthermore, Mellon has not paid much attention to the fact that no matter how old the lesion may be the blastomycosis organism found there does not change from its yeast-like, budding growth until it has been transferred to artificial media, where the change is an adaptation to the mode of life it must lead; in other words, the change from active parasitism to one of saprophytism. It is to be understood, however, that a change such as suggested here will not necessarily reduce its viability, at least for the time being.

A study of the evolution of the organism has repeatedly shown, in several hanging-drop cultures, that reproduction is heterogamous, as given in the description, with the final formation in the series of a large eight-spored ascus. Mellon in his papers consistently shows a four-spored ascus. It would seem, therefore, that he either has an organism unlike the one here described for the blastomycosis parasite, or else he has taken for granted as spores the four oil droplets which may and often have been found to occur on a mature eight-spored ascus, as was evidenced by the author on another ascomycete, *Endomyces capsulatus* var. *isabellinus* Moore, which was described in a case in another paper (McBride and Thompson, '33) and also in *Endomyces*

capsulatus Rewbridge, Dodge and Ayers ('29). Furthermore, it is quite possible that Mellon has observed the ascus just previous to the division of the nuclei, in the formation of the eight-spored ascus. This latter statement is only a conjecture on the part of the writer, but in any case the cultural descriptions do not agree with those given by the early investigators and with which the organism here described does agree.

In view of such criteria, it would seem that the organism formerly described as *Blastomyces dermatitidis* Gilchrist 1894, is not strictly a member of that genus, the name of which, on account of its etymological derivation, is essentially a misnomer. Because of its morphological characteristics, *Blastomyces dermatitidis* does not present those affinities entirely but simply as one phase of its life cycle. However, particularly because of its ascomycetous attributes, it should belong to the class Ascomycetes, order Endomycetales, family Endomycetaceae, and because of its similarity in morphology and reproduction (perfect stage) to that of *Endomyces capsulatus* and its variety, it should belong to the genus *Endomyces*. If taxonomic position in this family and genus be dependent on the number of spores in the ascus, it would seem, according to Whitman ('13), that this organism should belong in the genus *Oleina*. However, the genus *Endomyces* contains a number of pathogenic species with eight-spored asci, whereas *Oleina* has no pathogenic species, and until a classification better than the one now in existence be established, *dermatitidis* should be placed with *Endomyces*.

From the above statement it would appear that the organism should now be known as:

Endomyces dermatitidis (Gilchrist 1894), M. Moore, n. comb.

Mycelium in lesions of budding yeast-like cells 7–12 μ in diameter and sometimes as much as 20 μ in length, occurring singly, in groups of two's, three's, or four's. Growth on agar of isodiametric cells 2–2½ μ in diameter on acid media and 3–4 μ in diameter on slightly alkaline media. Hyphae septate, with conidia pyriform or round, pedunculate or sessile, 5 μ in diameter. Racquet mycelium present, 5–6 μ in diameter at swollen portion and 3–3½ μ in diameter at narrow portion. Chlamydospores terminal or lateral or intercalary, 5½–7½ x 12–15 μ, or sometimes

round, 7 μ in diameter. Copulation heterogamous, asci spherical, 8–13 μ in diameter, with 8 spherical to ovoid, smooth, hyaline to light chamois-colored spores 2–3 μ in diameter, at maturity. Colony white in color, becoming cinnamon to brown with age.

Summary

1. The history of blastomycosis is given, with a review of the early work on yeast-like, fungous pathogenicity, and a report of the first case published.

2. The etiology and clinical manifestations represent a number of conditions due to several yeast or yeast-like organisms: *Saccharomyces*, *Oidium*, *Monilia*, *Endomyces*, *Cryptococcus*, and *Coccidioides*, which have been placed in one category to constitute the agents responsible for the syndrome-complex, blastomycosis.

3. The disease is shown to simulate several conditions, in which cases the diagnosis must be arrived at through the isolation of the organism and the application of Koch's postulates.

4. Immunological reactions and therapeutic measures are as yet indefinite as to specific results, although beneficial results have been reported by the use of iodides.

5. A case of blastomycosis of the arm and hand is reported.

6. There is a description of the organism, culturally and morphologically, showing its relationship to the class Ascomycetes.

7. The fungus is definitely established as *Endomyces dermatitidis* of the family Endomycetaceae.

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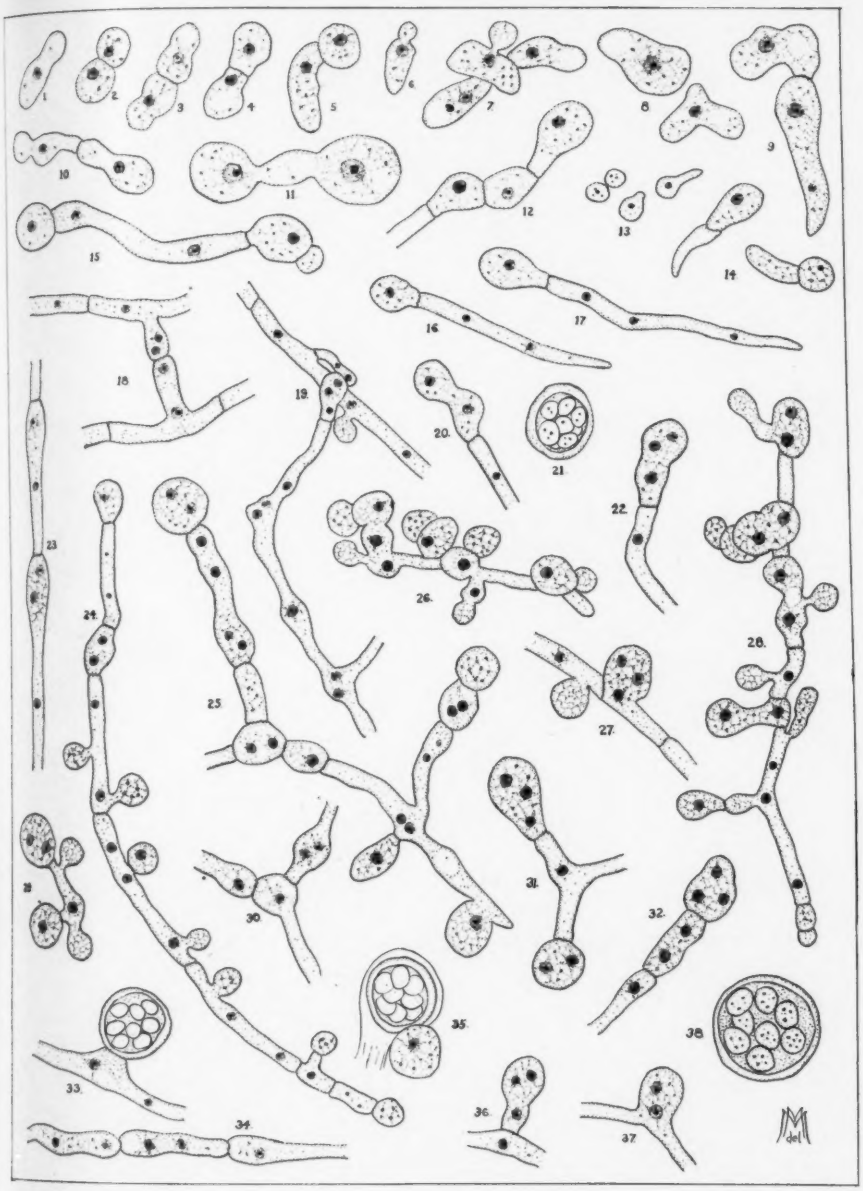
EXPLANATION OF PLATE

PLATE 6

All drawings made with camera lucida at a magnification of × 800.

Figs. 1–9. Yeast-like cells.
Figs. 1, 6, 7. On Raulin's solution.
Figs. 2–5, 9. On Sabouraud's agar.
Fig. 8. On glycerine agar.
Figs. 10–12, 14–17. Yeast-like cells showing a change to mycelial formation.
Figs. 10, 12. On potato-dextrose agar.
Figs. 11, 14. On glycerine agar.
Figs. 15–17. On Sabouraud's agar.
Fig. 13. Germinating spores on Richards' solution agar.
Fig. 18. Heterogamous copulation of lateral cells on Sabouraud's agar.
Fig. 19. Heterogamous copulation of terminal cells on Richards' solution agar.
Fig. 20. Copulating branch on corn-meal agar.
Fig. 21. Maturing ascus on Richards' solution agar.
Fig. 22. Terminal hypnospore on Sabouraud's agar.
Fig. 23. Racquet mycelium on June-beetle agar.
Fig. 24. Mycelium showing conidia on Richards' solution agar.
Fig. 25. Mycelium showing round terminal chlamydospores and swollen hypha on nutrient agar.
Figs. 26, 28. Mycelium showing conidia, oidia-like cells, and resting cells on corn-meal agar.
Fig. 27. Chlamydospore on Czapek's agar.
Fig. 29. Mycelium showing conidia on potato-dextrose agar.
Fig. 30. Racquet formation on Czapek's agar.
Fig. 31. Terminal chlamydospore on lactose agar.
Fig. 32. Terminal hypnospore on Endo's agar.
Fig. 33. Maturing lateral ascus on Sabouraud's agar.
Fig. 34. Racquet mycelium on June-beetle dextrose agar.
Fig. 35. Ascus covered with a third sheath in proximity to a round resting cell, on potato-dextrose agar.
Fig. 36. Lateral chlamydospore on Czapek's agar.
Fig. 37. Resting cell on Sabouraud's agar.
Fig. 38. Mature ascus on potato-dextrose agar.



MOORE—BLASTOMYCOSIS

Explanation of Plate

PLATE 7

Fig. 1. Photograph of hand of patient on day of entry, April 8, 1932, showing lesion involving portion of thumb.

Fig. 2. Photograph taken on April 8, 1932, showing abscess on flexor surface of left lower arm.

Fig. 3. Photograph showing marked improvement after treatment with sodium iodide intravenously.

Fig. 4. Photograph showing almost complete healing.

MOORE—BLASTOMYCOSIS

A MONOGRAPH OF THE AMERICAN SPECIES OF THE GENUS HALENIA[1]

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INTRODUCTION

Frequent attempts to determine recent collections of *Halenia*, especially from Central and South America, have revealed the need for a comprehensive taxonomic treatment of the American species of the genus. Incidental determination of isolated species in herbaria, which furnish scanty material, has led to error and the duplication of species has resulted. Few of these fragmentary treatments are provided with adequate descriptions, and still fewer are accompanied by illustrations. The present paper is a monographic study of the American species of *Halenia*. The first portion is devoted to the North and Central American representatives of the genus and the second to those of South America.

The writer at this time wishes to express her appreciation to Dr. George T. Moore, Director of the Missouri Botanical Garden, where this work has been carried on, for the privilege of using the facilities afforded by the herbarium, library, and laboratory. It is with pleasure, indeed, that she also acknowledges the courteous assistance and helpful criticism offered by Dr. J. M. Greenman, under whose personal supervision the study was begun and completed.

For the loan of specimens for study the writer is especially indebted to the curators of the herbaria of the following institutions: Gray Herbarium of Harvard University, New York Botanical Garden, Philadelphia Academy of Natural Sciences, United States National Herbarium, Field Museum of Natural History, the Dudley Herbarium of Stanford University, Brooklyn Botanic Garden, Iowa Agricultural College, Natural History Mu-

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

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seum of Vienna, Botanical Museum of Stockholm, the Delessert Herbarium at Geneva, Royal Botanic Gardens, Kew, and the British Museum of Natural History.

Particularly does the writer wish to express her gratitude to Mr. R. I. Cratty, of the Iowa State College, for the loan of specimens from the Parry Herbarium deposited there; to the curator of the Herbarium of the Botanical Garden of Madrid, for supplying a photograph of the type of *Swertia cucullata;* and to the curator of the Herbarium of the Jardin des Plantes, Paris, for photographs of the types of Humboldt, Bonpland and Kunth.

In connection with visits to various herbaria, the author desires to acknowledge the courtesy and kindly assistance of Dr. Ernst Gilg and Dr. Robert Pilger, of the Botanical Garden at Berlin-Dahlem; Dr. Walter Robyns of the Botanical Garden, Brussels; and Mr. Spencer Savage, in charge of the Linnaean Herbarium, of the Linnaean Society of London. Thanks are due also to Dr. George E. Nichols, Director of the Marsh Botanical Garden, Yale University, for his kindness in procuring seeds of *Halenia;* to Miss Nell C. Horner, Librarian of the Missouri Botanical Garden, and Dr. John H. Barnhart, of the New York Botanical Garden, for assistance in bibliography; to Dr. Roland V. La Garde, of the Missouri Botanical Garden, for preparation of photographs; and to the George F. Cram Company, for permission to use the copyright outline maps of North and South America.

History of the Genus

Linnaeus in the 'Amoenitates Academicae,'[1] which appeared in 1751, published short descriptions of two genera of the Gentianaceae, namely, *Swertia*, consisting of five species, and *Gentiana*, of twenty-three. Under *Swertia* Linnaeus listed the spurred gentian with the following description.

"4. Swertia corollis quadrifidis quadricornibus.
Amoen. acad. 2. p. 344.
Habitat in Sibiria, Gmelin; Canada, Kalm."

This was apparently the only species of spurred gentian he had

[1] Linnaeus, Amoen. Acad. 2: 344. 1751.

ever seen, and, it being closely related to the *Swertia* he knew, he placed it in that group, giving it the specific name *corniculata* or "horn-tipped," as distinct from the others.

Gmelin, in his 'Flora Sibirica,'[2] published in 1769, referred to this as being synonymous with his genus *Tetragonanthus*, which he had described or mentioned in a previous book or manuscript, and which he evidently based upon specimens collected by G. H. Stellar. This work contains a brief description, but a good illustration of *Swertia*.

On account of the presence of spurs on the corolla, Börckhausen,[3] in 1796, segregated *Swertia corniculata* from the Linnaean genus *Swertia* and called it *Halenia* after Jonas Halen. Although the latter had included a short description of it in a previously published dissertation on Kamtchatka plants, Börckhausen must be considered the author of the genus. He cited as a synonym *Swertia corniculata* Linnaeus, but changed the binomial name to *Halenia sibirica*.

The name *Swertia*, however, persisted for some time in literature, the generic descriptions becoming more elaborate and detailed with each publication. Ruiz and Pavon described and illustrated *Swertia umbellata* from Peru[4] in 1802. Michaux included the genus in his 'Flora Boreali-Americana'[5] appearing the following year, and Humboldt, Bonpland and Kunth,[6] described six new species from Mexico and South America in 1818. A few species, together with a new variety, were published in 'Linnaea' by Schlectendal and Chamisso[7] in 1830. But it was not until Grisebach began his extensive study of the Gentianaceae that any attempt was made to bring together the species of the world. As a result, when his 'Observationes'[8] appeared in 1836, followed in 1839 by the 'Genera et Species Gentianearum,'[9] many of the existing names fell to synonymy.

Grisebach divided *Halenia* into two main divisions: the first,

[2] Gmelin, Fl. Sib. **4**: 114. 1769.
[3] Börckhausen in Roemer, Arkiv für Botanik 1[1]: 25. 1796.
[4] Ruiz & Pavon, Fl. Peruv. **3**: 21. *pl. 242*. 1802.
[5] Michaux, Fl. Bor.-Am. **1**: 97. 1803.
[6] Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. **3**: 174. 1818.
[7] Schlectendal & Chamisso in Linnaea **5**: 122. 1830.
[8] Grisebach, Obs. Gent. 36. 1836.
[9] Grisebach, Gen. & Sp. Gent. 322–328. 1839.

with spurs ascending and spreading; the second, with spurs pendulous to incurved. He devoted careful attention to the descriptions, synonymy, affinities, differentiating characters, and habitat of each species mentioned. The collector and type were given in each case. He also separated from the *Swertia* of Humboldt, Bonpland and Kunth two species, *brevicornis* and *parviflora*, and founded on them a new genus *Exadenus* distinguished by the presence of pits at the base of the corolla, instead of spurs, and by central placentation. This abolished the *Swertia* of Humboldt, Bonpland, and Kunth, which was based on *Swertia corniculata* Linnaeus, and left the non-spurred *Swertia* originally described by Linnaeus a genus entirely distinct from our present *Halenia*.

Hooker's 'Flora,'[10] published in 1840, contained good illustrations of *Halenia deflexa* with the varieties *Brentoniana* and *heterantha*.

Nearly a decade elapsed before any significant study was done on the genus as a whole. Bentham,[11] in 1839–1840, in describing Hartweg's plants from Mexico added two new species, *multiflora* and *decumbens*. Martens and Galeotti in 1844 in their "Enumeration of Mexican plants collected by Galeotti"[12] described, along with other new *Halenia* species, two new species of *Exadenus*. Walpers' 'Repertorium'[13] contains reference to *Exadenus*, but Weddell in 1859[14] merged the two genera. He considered the group as a whole to consist of two main subdivisions, the first being that group with spurs, and the second the spurless species. The former he subdivided into section 1—ovary unilocular; section 2—ovary bilocular, and the corolla having small spurs. Here he placed the two original species of *Exadenus* Grisebach which were based on the species of *Swertia* Humboldt, Bonpland & Kunth, namely, *parviflora* and *brevicornis*, but neglected to transfer the species described by Martens and Galeotti. The second subdivision, without spurs, he also divided into two sections, on the presence of a uni- or bilocular ovary.

[10] Hooker, Fl. Bor.-Am. **2**: 67. *pl. 155–6.* 1840.
[11] Bentham, Pl. Hartw. 24. 1839; 67. 1840.
[12] Martens & Galeotti in Bull. Acad. Brux. **11**[1]: 370. 1844.
[13] Walpers, Rep. Bot. Syst. **6**: 508. 1846–47.
[14] Weddell, Chlor. And. **2**: 74. 1859.

His argument for combining the two genera was based on the fact that the two characters, the bilocular ovary and the short spurs do not always coincide. In this work, he described five new South American species based on collections of Triana, Funck & Schlim, Goudot, Purdie, etc.

At the time of the publication of Bentham and Hooker's 'Genera Plantarum,'[15] 1876, there were about twenty-five recognized species of *Halenia* from the whole world.

Hemsley, in 'Biologia Centrali-Americana,'[16] which appeared in 1882, referred the *Exadenus* Martens and Galeotti to *Halenia*. Gilg in Engler and Prantl's 'Natürlichen Pflanzenfamilien'[17] recognized the validity of the generic name *Halenia* and included a careful description and good illustrations.

Sessé & Mociño's 'Flora'[18] contains a description of *Swertia cucullata* which has escaped the notice of succeeding monographers, and has not been transferred to *Halenia*. A photograph of the type specimen kindly furnished by Dr. E. Balguerias, Curator of the Botanical Garden at Madrid, reveals the fact that it is without question *Halenia brevicornis* Griseb., though it is rather difficult to determine whether or not it is the species proper or one of its many forms.

From this time until the monographic treatment of South American species was published by Gilg[19] in 1916, several species and varieties of Mexican and Central American *Halenia* were published. *Halenia Rothrockii* Gray,[20] now *Halenia recurva*, in 1876 was based on plants collected in Arizona by Dr. J. T. Rothrock. G. Don, in 1838, in the 'General History of the Dichlamydeous Plants'[21] included a description of the existing species of *Halenia*, making several new combinations from the species of Humboldt, Bonpland and Kunth.[22] Some of his species were taken from the manuscript of D. Don, thus appearing in

[15] Bentham & Hooker, Gen. Pl. **2**: 817. 1876.
[16] Hemsley, Biol. Cent.-Am. Bot. **2**: 351. 1882.
[17] Gilg in Engler & Prantl, Nat. Pflanzenfam. **4**²: 89. 1895.
[18] Sessé & Mociño, Flora Mexicana, 73. 1894.
[19] Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, pp. 93–122. 1916.
[20] Gray in Proc. Am. Acad. **11**: 84. 1876.
[21] Don, G. Gen. Hist. **4**: 177. 1838.
[22] Humboldt, Bonpland & Kunth, Nov. Gen. & Sp. Pl. **3**: 174. 1818.

publication for the first time. Kuntze,[23] in 1891, revived the generic name *Tetragonanthus* Gmelin. He has been followed by a few later taxonomists, among whom are Britton,[24] Small,[25] Rydberg,[26] and others. However, *Halenia* was placed on the list of *nomina conservanda*, and thus must be regarded as the correct name in accordance with the International Rules of Botanical Nomenclature. *Halenia crassiuscula* Robinson and Seaton[27] appeared in 1893. Britton,[28] in 1894, reduced *H. Brentoniana* Grisebach to a variety of *Tetragonanthus deflexus*, while in 1899 Fernald[29] placed *H. heterantha* Grisebach under *Halenia deflexa* var. *heterantha*. Other new species and new combinations appeared in rapid succession, due to the extensive collecting done during the period from 1890 to about 1920, by Conzatti, Pringle, Purpus, and others in Mexico, and Weberbauer in South America. Among these newly published species were: *Halenia candida* Ramirez,[30] 1895; *H. chlorantha* Greenman,[31] 1905; *H. bella*, *H. caespitosa* Gilg,[32] 1906; *H. Conzattii* Greenman,[33] 1912; *H. guatemalensis* Loesener, and *H. plantaginea* var. *latifolia* Loesener[34] (now *H. guatemalensis* var. *latifolia* (Loesener) Allen) 1913.

The type species up to this time had been called *H. sibirica*, the name given it by Börckhausen. However, according to the rules of priority, *sibirica* should give way to the older name *corniculata* used by Linnaeus. Accordingly, Druce[35] in 1914 revived *corniculata* which is at present the accepted name for the type species of *Halenia*. Britton and Brown in the 'Illustrated Flora,'[36] reduced Grisebach's species *Brentoniana* and *heterantha* to varieties of *deflexa*.

[23] Kuntze, Rev. Gen. Pl. 2: 431. 1891.
[24] Britton, Manual, 734. 1901.
[25] Small, Fl. Southeastern U. S. 931. 1913.
[26] Rydberg, Fl. Rocky Mts. 666. 1922.
[27] Robinson & Seaton in Proc. Am. Acad. 28: 113. 1893.
[28] Britton in Mem. Torrey Bot. Club 5: 261. 1894.
[29] Fernald in Rhodora 1: 37. 1899.
[30] Ramirez in Inform. Secret. Foment. Mexic. (Excurs. Mont. Ajusco). 34. 1895.
[31] Greenman in Proc. Am. Acad. 41: 240. 1905.
[32] Gilg in Fedde, Rep. Spec. Nov. 2: 52. 1906.
[33] Greenman in Publ. Field Mus. Bot. 2: 335. 1912.
[34] Loesener in Verh. Bot. Ver. Brandenb. 55: 182. 1913.
[35] Druce in Rept. Bot. Exch. Cl. Brit. Isles 3: 419. 1914.
[36] Britton & Brown, Ill. Fl. 3: 15. 1913.

Gilg,[37] in 1916, monographed the South American representatives of the genus, adding several new species. At that time, the herbarium at Berlin contained as complete a series of South American plants as were to be found anywhere, but, in some cases at least, the material was too inadequate to determine the limits of variation of certain of the species proposed. Hence, some of the species recognized, studied in the light of subsequent collections, have fallen into synonymy. Gilg created three main divisions:

A. Nectaria parva vel obsoleta, rarius extrinsecus breviter semigloboso-prominentia. Folia manifeste carnoso-subcoriacea.

B. Nectaria haud calcariformia, sed extrinsecus ad basin corollae alte globoso- vel coniformi-prominentia. Folia semper tenuiter herbacea.

C. Nectaria extrinsecus calcaria manifeste evoluta formantia.

Division A contains the largest known *Halenia*, native of South America only, which in inflorescence, flower, and leaf habit, shows affinities with the western species of *Swertia* and *Frasera* as well. Plants in division A are very distinct and occur in Colombia and Venezuela. These Gilg apparently considered the most primitive.

In division B we find the *brevicornis-parviflora* complex. Gilg considered *H. brevicornis* (HBK.) Don a valid species known only from South America, and *parviflora* a native of Mexico; he further described a new species *erythraeoides* from Venezuela which agrees in every respect with the *parviflora* type from Mexico.

Division C is subdivided according to the length of spurs; here again, confusion has occurred, as is apt to be the case when herbarium material is scanty and field work impossible. From a limited experience in the field with a North American species, the author can state with conviction that it is possible for two plants belonging to the same species, growing side by side, to vary not only in form but in size as well. It has been found also that the spur character is inconstant. Axillary flowers and those blooming late in the season frequently possess shorter spurs or no spurs at all. If this character is so variable in one species, it

[37] Gilg in Engl. Bot Jahrb. 54: Beibl. 118, p. 93. 1916.

is reasonable to suppose that the same situation may obtain in other species. Only close attention to ecological detail and a wealth of material not yet available from South America can enable the monographer to delimit species from these little-known regions even with a fair degree of accuracy.

Briquet,[38] in 1931, described several new species which will be treated below.

Gross Morphology

Habit.—The American species of the genus *Halenia* are glabrous, strictly herbaceous, or somewhat ligneous annuals or perennials. They may be of caespitose habit, as is illustrated by *H. caespitosa*, or coarse, fleshy, foliose plants with single stems, 5 or more dm. high, as in *H. hygrophila* and related species, or scapose with the basal leaves disposed in a rosette, as in *H. plantaginea*, or slender, graceful, simple or branching plants 1.5–6 dm. high, as in *H. brevicornis* and its varieties. As a whole, the genus is not colorful, the flowers being various shades of yellow and yellow-green, except in the northernmost species, which has purple flowers.

Roots.—The root system of the North American species is fibrous, with a persistent, slender tap-root, frequently more or less woody in texture, though typically that of an annual or perennial in cross-section. In the South American species the root is, for the most part, ligneous and thick.

Stems.—The stems are simple or branched, usually erect, though they may be decumbent, as in *Halenia decumbens* and *H. Weddelliana*. They are of two types, mostly foliose as in *H. deflexa* and *Schiedeana*, or scapose as in *H. plantaginea*. The stems often continue underground for a short distance, sending out erect, flowering stems at irregular intervals. These may be angular or terete; if the former they are often slightly winged, due to the decurrence of the leaves, and usually faintly striate.

Leaves.—The leaves are opposite and decussate, or infrequently whorled as in *H. verticillata*, either entirely cauline or disposed in a rosette, sessile or petiolate. The petioles exhibit the same characteristics as the stem, the decurrence of the calyx-lobes

[38] Briquet in Candollea 4: 317. 1931.

frequently being apparent. Where both petiolate and sessile leaves occur on the same plant, the basal leaves have petioles often equal to or longer than the blade, and the petioles become decreasingly shorter toward the summit of the stem, the uppermost leaves being sessile. The leaves are entire, 1-, 3- or 5-nerved, and range from ovate to obovate or spatulate, or lanceolate to linear, varying from .5 to 8 or 10 cm. in length and up to 6 cm. in width. The leaves of the North American species are, on the whole, thin and herbaceous, whereas in the South American species they are frequently coarse, fleshy, or coriaceous.

Inflorescence.—The inflorescence consists of terminal or axillary cymes of varying density. The flowers occur on short pedicels at the tip of a stem or branch in a compact cluster or head, as in *H. brevicornis*, or they may be borne loosely on long pedicels at the tip of a branch or at a node, as in *H. Schiedeana*. In the Central American and the more primitive of the South American species, the inflorescence is usually a spicate, racemose, or more or less umbellate cyme. A pair of small, linear, foliaceous bracts is usually present at the base of the inflorescence, often bearing tiny, undeveloped buds in their axils. Frequently the bracts approximate the leaves in size and structure, and in *H. involucrata* they form an involucre almost entirely enveloping the inflorescence.

Calyx.—The calyx is persistent, foliaceous, 4-parted, and the segments united only at the extreme base and arranged in pairs; the inner pair represents an inner cycle, the second an outer cycle. The segments may be caudate as in the type species, *H. corniculata*, or spatulate, obovate, elliptic, lanceolate-linear, or linear, with intergradations, with obtuse, acute, acuminate, mucronate or apiculate tips. The tips very rarely are reflexed, as in *H. Schiedeana*. The length of the calyx varies from one-third to nearly equal that of the corolla. The calyx-segments are from 1- to 3-nerved, often reticulately veined at the tip, and both surfaces are often papillate. Squamellae are usually found on the inner surface of the calyx-segments at their base (see fig. 1). They vary in size, shape, number, and position on the lobes, and

are usually distinguishable only under the dissecting lens after the herbarium specimens have been boiled. Squamellae occur in many of the *Contorti* both on the calyx and the corolla-lobes. Engler and Prantl[39] have referred to similar structures in several genera of the Gentianaceae as discs.

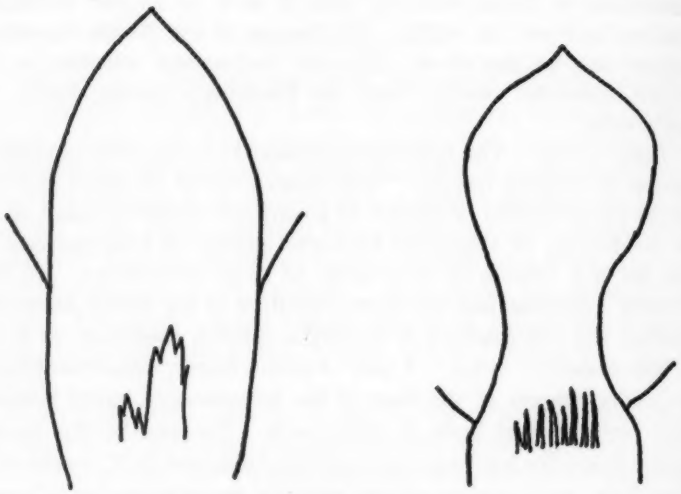


Fig. 1. Types of squamellae found on the calyx in the genus *Halenia*.

Corolla.—The corolla is marcescent, campanulate, 4-lobed, white, yellow, yellow-green, green, or purple, ranging in length from 5 mm. to nearly 3 cm. The lobes are triangularly ovate or obovate, acute, acuminate, apiculate, mucronate or obtuse, often auriculate, with an entire, erose, or crisped margin, and frequently papillate on both surfaces. The veining of the dextrorsely convolute lobes may or may not be reticulate. The corolla-tube varies from one-fourth to three-fourths the length of the entire corolla. At or near the base of the tube, opposite each lobe, is a tubercle which may be merely a slight swelling in the lower portion of the tube, as in *H. brevicornis*, or a definite

[39] Gilg in Engler & Prantl, Nat. Pflanzenfam. 4[2]: 89. 1895.

spur longer than the corolla, as in *H. guatemalensis* (pls. 8–11). It frequently happens that the corolla lacks spurs entirely in the axillary flowers or in those occurring late in the season, as, for example, in *H. deflexa* and other species. Not only in *Halenia* is this situation apparent, but it is recalled that in other normally spurred plants, for example, *Linaria canadensis*, spurs are frequently absent. Therefore it has seemed advisable to discontinue *heterantha* as a variety of *H. deflexa*, since the occurrence of these spurless forms is more or less frequent within the genus. Gilg noted that in certain species of *Halenia*, for example, *H. brevicornis*, etc., the flowers on the main stalk are normally large and wide open, while below, on the same stem, they are definitely smaller, apparently not opening at all or else very slightly. The structure is similar, with the exception of the absence of spurs. The ovary in these abnormal flowers contains fewer seeds, and the capsule is much reduced in size. This would indicate, according to Gilg, a gradual reduction of chasmogamous flowers which depend on insect pollination, to more or less cleistogamous flowers. The shape of the spurs varies exceedingly, from slender to very thick and broad, or from spreading and ascending to pendulous and incurved. Intergrading forms are frequent. The spurs are frequently conspicuously veined and apparently glandular.

Stamens.—The stamens are equal in number to, and are borne alternate with, the lobes of the corolla at or near the summit of the tube. The filaments are adnate to the corolla, and the anthers are often enfolded in the bud by the margins of the corolla-lobe. The anthers are versatile, deltoid, ovate or oblong, often mucronate and papillate. The filaments are usually linear, but they may become more or less dilated and, rarely, papillate. The pollen grains are constant for the genus, being more or less tetrahedrally spherical, and having three pores.

Pistil.—The pistil is sessile. The stigma is usually sessile and cleft to expose the two inner stigmatic surfaces; the lobes may be truncate or ovate. The ovary is bicarpellate, the margins of each carpel being infolded and becoming the region of attachment for the numerous ovules.

Fruit.—The fruit is a flattened, lanceolate to lanceolate-

obovate capsule, frequently subfalcate, and usually exserted. It is unilocular at maturity, though in the young state it appears to be more or less two-celled. The fruit dehisces septicidally along the inner surface of each locule tip.

Seed.—The seeds vary in shape, being globose to ovoid or elliptic, often flattened. The surface is reticulate in the majority of the South American species and in the *brevicornis* complex, except for var. *latifolia*. The remaining species show the surface of the seeds to be minutely granular instead of reticulate. They vary in size from 0.5 to 1 mm. in diameter, and in color from dull greenish-brown and yellow-brown to dark, shiny brown, the latter usually being typical of those with reticulate surface. The age of the plant and the conditions attending its collection no doubt have their influence on the color, size, and, to some extent, the texture of the seed-coat.

Floral Anatomy

The major portion of the anatomical investigation of the Gentianaceae, particularly the Menyanthoideae, has been concerned with the stem and leaf structure. The most complete anatomical data is found in Gilg's treatment of the Gentianaceae in 'Die Natürlichen Pflanzenfamilien.'[40] Solereder's 'Systematic Anatomy of the Dicotyledons'[41] gives very little additional information. Since that time more attention has been given to floral morphology as a separate study. Stolt,[42] in 1921, made an exhaustive cytological survey of the flowers of several genera, among which was included *Halenia elliptica*, an Asiatic species having affinities with *Halenia deflexa* of North America. Incidentally, Stolt inserted a diagram of the transverse section through the ovary, which indicates clearly the vascular system of that portion of the flower.

In order to make the present monograph as complete as possible, anatomical study was undertaken. Fresh flowers of *Halenia deflexa*, a species with both spurred and spurless forms, were obtained by the author in Vermont and preserved in 70 per cent

[40] Gilg in Engler & Prantl, Nat. Pflanzenfam. 4³: 50. 1895.
[41] Solereder, Systematic Anatomy of the Dicotyledons 1: 548–550. 1908.
[42] Stolt in K. Svensk. Vet.-Akad. Handl. 61¹⁴: 1–56. 1921.

alcohol. The pickled material was dehydrated and embedded in paraffin following the butyl alcohol method outlined by Zirkle,[43] sectioned at 10 μ, and stained with crystal violet and erythrosin. The accompanying drawings (pl. 12) were made with the aid of a "Promi" microscopic drawing and projecting apparatus. The xylem has been cross-hatched in order to differentiate it from the other vascular elements.

Transverse sections of the spurred form of *Halenia deflexa* show that the vascular system of the pedicel is an amphiphloic siphonostele (pl. 12, fig. 1). Approaching the receptacle, the stele enlarges and assumes a rhombic form (fig. 2). The decurrence of the outer lobes of the calyx is apparent. Shortly thereafter (fig. 3), the midribs (a) of the two outer calyx-lobes leave the receptacular stele (r). They migrate outward, and from either, two lateral traces (a′) are given off (fig. 4). At this point, four lacunae (z) appear, prior to the severing of the calyx from the receptacle. In the succeeding illustration (fig. 5) these lacunae (z) merge into two crescent-shaped fissures, and the midribs of the two inner calycine lobes (b) leave the stele.

In fig. 6 the calyx-tube is entirely free from the receptacle, and in the axil of each potential lobe are visible 4–8 minute emergences or squamellae (e). The stele has again assumed a more or less rhombic shape, but from the 4 angles, traces (c) depart centrifugally, soon resolving into the midrib (n) and two laterals (c′) destined to supply each of the 4 corolla-lobes (fig. 7).

The disruption of the residual vascular cylinder is continued, and the 4 staminal traces (f) are fully differentiated. At this interval the corolla-tube is virtually free from the receptacle.

In the succeeding illustration (fig. 8) lacunae appear at m, the ovary at this point appearing bilocular. The residual stele consists of two roughly semi-circular masses with a concentration of lignified elements (l) at either end. The calyx-lobes are free, and sections near the tip of the reflexed spurs are found, the origin of which is to be described.

In the following illustration (fig. 9) the origin of the spurs is apparent, and a cleft (y) is visible, indicating the sinus. Simultaneously, 4 protrusions occur on the inner surface of the corolla,

[43] Zirkle in Science, N. S. 71: 103. 1930.

below the sinus, preparatory to the severing of the staminal filaments (f). The ventral traces (l) and dorsal (k) are discernible. The ovules (o) are evident, showing their position in the axils of the placentae (p).

In the final stage, taken from a section through the tip of the flower (fig. 10), the differentiation of the corolla-lobes and the isolation of the staminal filaments (f) are complete. The placentae (p) have diminished in size.

The spurless form shows a similar vascular system except for the absence of spurs, the presence of fewer ovules, and finally, a more pronounced dorsal trace (k), after the cessation of ovular production.

Geographical Distribution

The accompanying maps show three centers of distribution of the species of *Halenia* in America. The first (figs. 2, 4) extends from Labrador and Newfoundland, south to New York and west to British Columbia and Montana. The one species and its variety found in this area grow in moist or dry situations in calcareous, slaty, or alluvial soil, in open woods or fields, on stream banks or along the sea-shore, usually in the shade. The habit varies with the habitat. This distribution follows closely the northern region of glaciation, and coincides with the usual distribution areas of herbaceous species common in that territory. This same species has been collected three times in the State of Mexico, but has not been reported from the intervening region, a fact that might suggest a previously more continuous distribution of the species from the northern Rockies along the mountain ranges to the Mexican Sierras.

The second area comprises a region extending from the Chiricahua Mountains of New Mexico and Arizona, southward to Costa Rica in Central America. Here are a few wide-spread mountain species; but for the most part, they are endemics occurring in volcanic areas (fig. 3).

The third large center of distribution is the northern part of South America, where the genus is represented by a relatively large number of endemic species (fig. 5).

All of the North and Central American species, with the

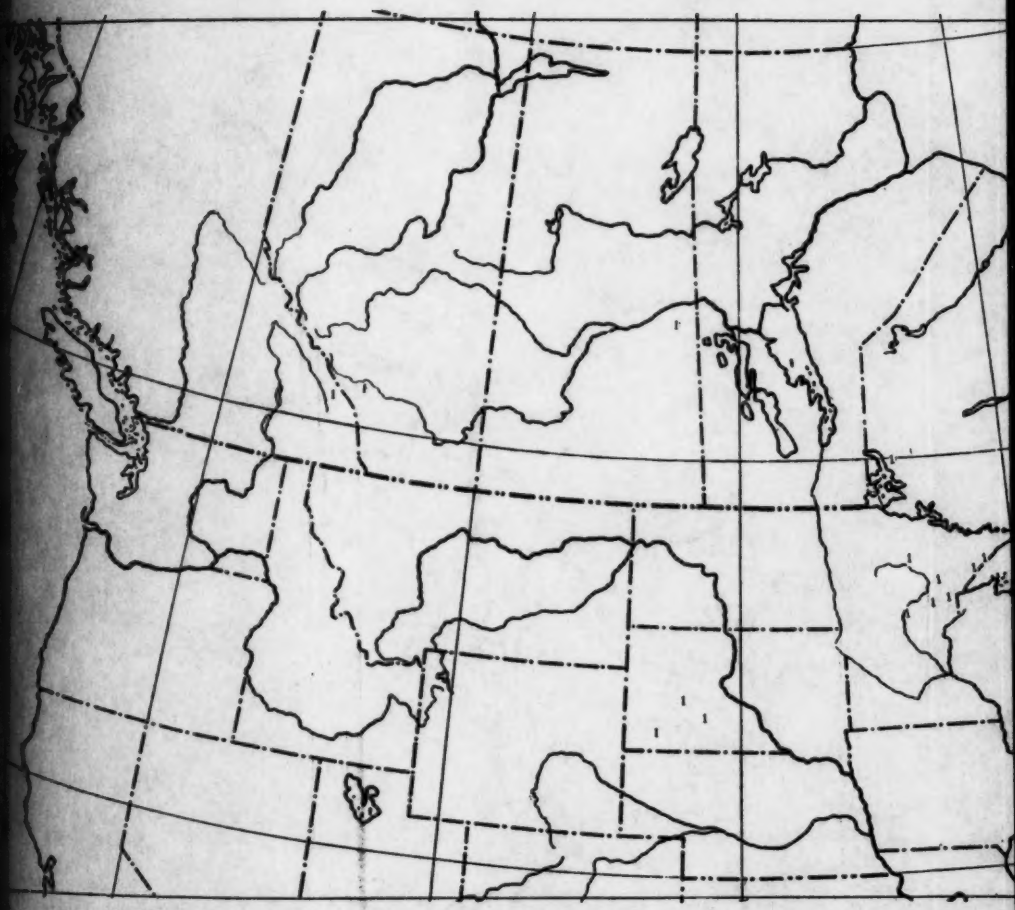
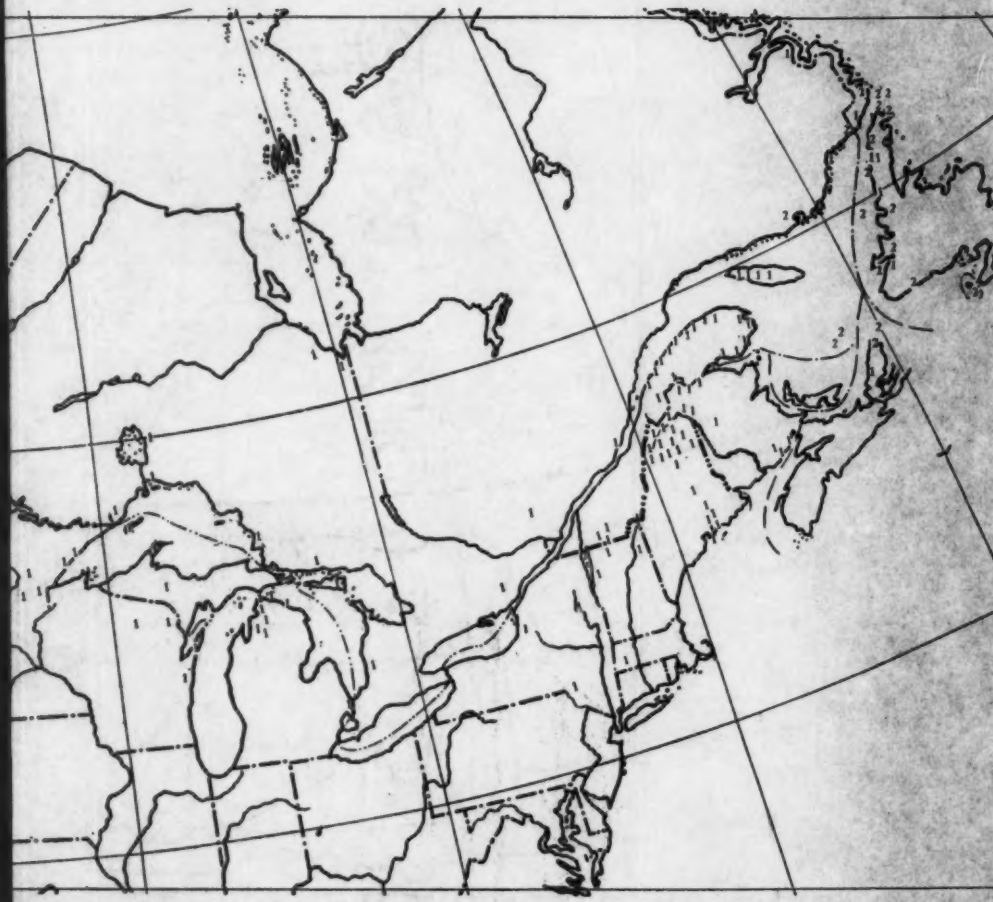


Fig. 2. Map of southern Canada and northern United States, showing the geographical dis



aphical distribution of the species of *Halenia:* 1 = *H. deflexa;* 2 = *H. deflexa* var. *Brentoniana.*

Fig. 3. Map of southern United States, Mexico, and Cen

14. *H. brevicornis*
19. var. *chihuahuensis*
18. var. *divergens*
15. var. *latifolia*
17. var. *micranthella*
16. var. *multiflora*
20. var. *ovata*
21. var. *Tuerckheimii*
29. *H. caleoides*
6. *H. Consattii*
4. *H. crassiuscula*
13. *H. decumbens*
25. *H. guatemalensis*
30. var. *latifolia*
12. *H. nudicaulis*

exico, and Central America showing the geographical distribution of *Halenia*.

rassiuscula
lecumbens
uatemalensis
r. latifolia
udicaulis

5. *H. Palmeri*
8. *H. plantaginea*
9. f. *grandiflora*
22. *H. platyphylla*
10. *H. Pringlei*
3. *H. recurva*
26. *H. rhyacophila*
28. var. *procumbens*
27. var. *macropoda*
11. *H. Schiedeana*
24. *H. Shannonii*
23. f. *compacta*

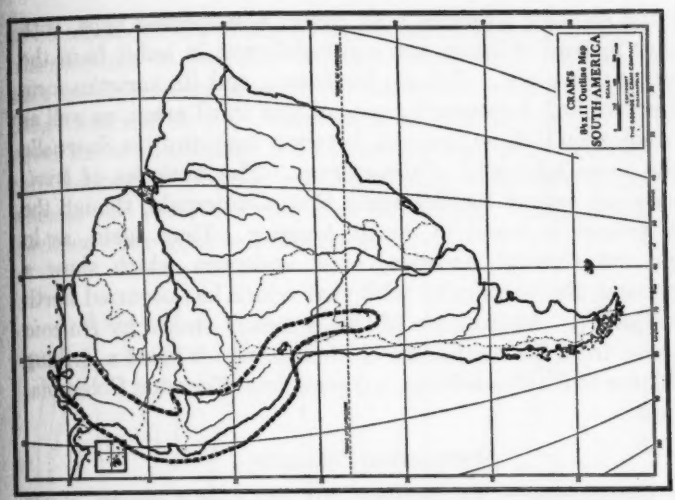


Fig. 5

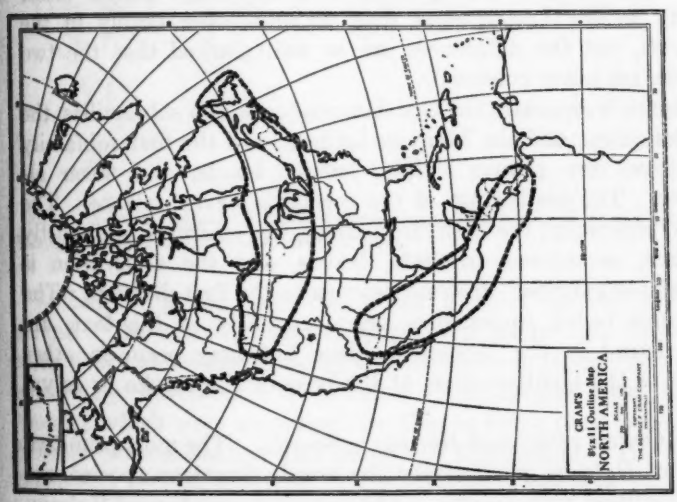


Fig. 4

Maps of North and South America, showing the principal areas of distribution of *Halenia*. (Maps reproduced by permission of the George F. Cram Company).

exception of *Halenia alata* and *H. brevicornis* and its varieties, are spurred forms which show a definite relationship to one another. Those from South America are of two types: spurred type, similar to the North American species (excluding *brevicornis* and

alata) and showing affinities with them; non-spurred type, with tubercles instead of spurs and quite different in habit from the *brevicornis* and *alata*. *Halenia brevicornis* and its varieties form a connecting link between the second and third areas, as well as a morphological link, so to speak, between the primitive *Swertiella* and the more advanced *Haleniastrum*. The varieties of *brevicornis* do not extend further south than Guatemala, though the species proper is found in South America. Here again, as in Mexico and Central America, exist endemics which show a development almost parallel with that which has occurred north of the equator. An example of this is clearly shown by *Halenia decumbens*, from the mountains of Mexico, which bears a striking resemblance to *H. Weddelliana*, a species from Ecuador, Colombia, and Peru.

Systematic Position

The Gentianaceae, as pointed out by Gilg,[44] shows closer affinity to the Loganiaceae than to any other family in the Contorti, yet the differences are so well marked that the two families are never confused.

Grisebach separates the Gentianaceae into two subfamilies, the Gentianoideae and the Menyanthoideae. In the first subfamily the leaves are always simple, entire, sessile, and never alternate. The aestivation of the corolla is never valvate. The second subfamily, the Menyanthoideae, has alternate and mostly petiolate, sometimes trifoliate, leaves, and the aestivation is induplicate-valvate. *Halenia* belongs to the first division. The structures called squamellae, described early in the text, are never found in the Menyanthoideae but may occur in other genera of the Gentianaceae, at the base of the corolla or calyx-lobes.

The nearest relative of *Halenia* is *Swertia*. The most primitive forms of *Halenia*, particularly the South American species, are often confused with *Swertia*. The primitive members of *Halenia*, instead of the definitely spurred corolla typical of the majority of the species of the genus, possess small, knob-like protuberances or nectaries which upon casual examination might pass unnoticed

[44] Gilg in Engler & Prantl, Nat. Pflanzenfam. 4[2]: 50. 1895.

or be taken for the nectaries which are structurally distinct and characteristic of *Swertia*. More detailed study reveals the fact that the depressions or spurs of *Halenia* are without the marginal fringe which is always conspicuous in *Swertia* (fig. 6). *Halenia* never has a corona, but in *Swertia* it is frequently present. The corolla-lobes of *Halenia* are dextrorsely convolute in the bud, whereas the reverse is the case in *Swertia*. Anatomical study discloses other generic differences.

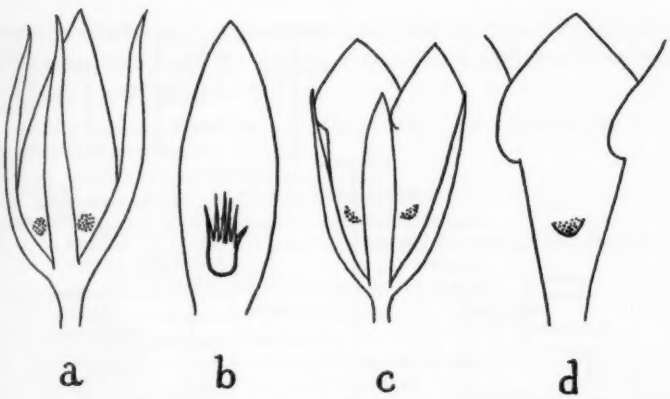


Fig. 6. *Swertia perennis* L.: *a*, bud; *b*, interior surface of petal. *Halenia brevicornis* (HBK.) Don: *c*, bud; *d*, interior surface of petal.

Within the genus itself two rather distinct sections are apparent. The more primitive, which was mentioned above as being near *Swertia* and possibly originating from it, may be called tentatively *Swertiella*. It contains those species from South America which were considered by Gilg as being most primitive. *Halenia alata* of Mexico also belongs to this section. The *Swertiellae* may be characterized by the absence of spurs or the presence of small tubercles or prominences at the base of the corolla, which are not visible usually from the outside. They are coarse, fleshy, foliose plants, and for the most part with dense inflorescences. The second section, *Haleniastrum*, is more advanced and is readily recognized by the presence of spurs of varying

length and shape. Both herbaceous and more or less woody types comprise this section.

An interesting discussion of the phylogeny of the Gentianaceae was presented by T. H. Huxley[45] before the Linnaean Society of London, April 7, 1887. Confining his study to the structure of the corolla, he separated the family into two groups; the first division *Permelitae* was segregated mainly on the presence of a series of nectarial cells on the inner surface of the cup. The *Permelitae* were again divided into four groups with various

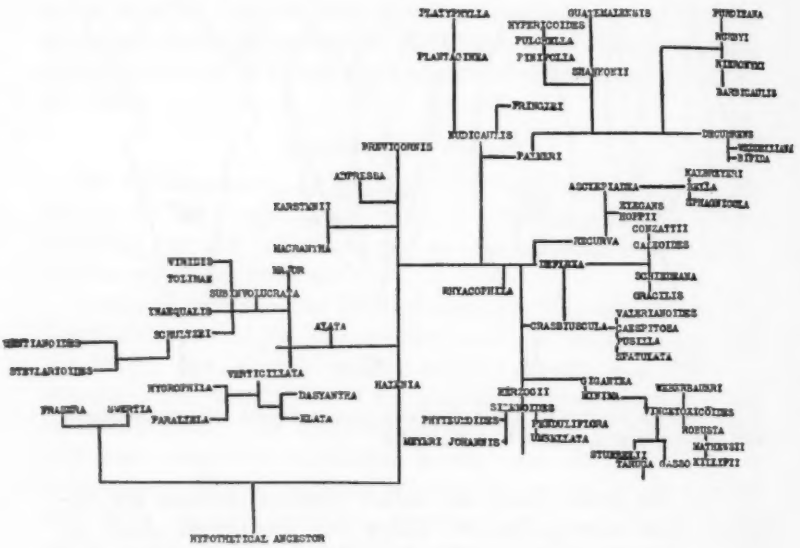


Fig. 7. Chart showing the probable phylogenetic relationship of species of *Halenia*.

modifications of floral structure. The first, *Actinanthe*, which he considered the most primitive and the least differentiated, contained among other elements, *Exadenus*. The latter was included as a transitional stage on account of its rudimentary spurs, leading to the second division, the *Keratanthe*, containing only one genus *Halenia*, which represents an extreme modification of the *Exadenus* type. The third related division, the *Lophanthe*,

[45] Huxley, T. H. Jour. Linn. Soc. Bot. **24**: 101. 1887.

depicts another outgrowth of the *Actinanthe* type, but with filamentous appendages or fimbriae. *Swertia* and *Frasera* fall into this category.

Text-figure 7 shows the probable relationship of the various species of *Halenia*, according to the author's interpretation.

For the sake of convenience, in the taxonomic treatment of the genus, the North and South American species are taken up separately in each section.

Abbreviations

In the citations of specimens examined the following abbreviations have been used to denote the various herbaria from which specimens were used for study.

ANSP = Herbarium of the Academy of Natural Sciences of Philadelphia.
BG = Botanical Garden, Berlin.
BB = Brooklyn Botanical Garden.
BM = British Museum of Natural History, London.
B = Herbarium of the Botanical Garden, Brussels.
C = Herbarium of the University of Chicago, deposited in the Field Museum of Natural History.
CAS = Herbarium of the California Academy of Sciences.
D = Dudley Herbarium of Leland Stanford Jr. University.
DH = Delessert Herbarium of Geneva.
F = Herbarium of the Field Museum of Natural History.
G = Gray Herbarium of Harvard University.
HP = Herbarium of H. Pittier, Director de Museo Comercial, Caracas, Venezuela.
HJP = Herbarium of the Jardin des Plantes, Paris.
IAC = Herbarium of the Iowa Agricultural College.
K = Herbarium of the Royal Botanic Gardens, Kew.
L = Linnaean Herbarium, Linnaean Society of Botany, London.
M = Herbarium of the Missouri Botanical Garden.
MU = Herbarium of the University of Missouri.
NY = Herbarium of the New York Botanical Garden.
P = Parry Herbarium deposited at the Iowa Agricultural College.
S = Herbarium of the Botanical Museum, Stockholm.
SM = Herbarium of the State Museum, Albany, New York.
UC = Herbarium of the Botanical Museum of the University of Copenhagen.
US = United States National Herbarium.
V = Herbarium of the Natural History Museum, Vienna.

Taxonomy

Halenia Börckh. in Roemer, Arkiv für Botanik 1[1]: 25. 1796; Ruiz & Pavon, Fl. Peruv. 3: 21, *pl. 242, fig. 1.* 1802; Endl. Gen. Pl. 601. 1836–40; Grisebach, Obs. Gent. 36. 1836; G. Don, Gen.

Hist. 4: 177. 1838; Grisebach, Gen. & Sp. Gent. 322. 1839; Dietrich, Syn. Pl. 2: 918. 1840; Hooker, Fl. Bor.-Am. 2: 67, *pl. 155–6*. 1840; Grisebach in DC. Prodr. 9: 128. 1845; Grisebach in Linnaea 22: 45. 1849; Weddell, Chlor. And. 2: 74. 1859; Benth. & Hooker, Gen. Pl. 2: 817. 1876; Hemsl. Biol. Cent.-Am. Bot. 2: 351. 1882; Baillon, Hist. Pl. 10: 142. 1891; Gilg in Engler & Prantl, Nat. Pflanzenfam. 4²: 89. 1895; Conzatti, Fl. Syn. Mexico, 174. 1897; Rouy, Ill. Pl. Eur. 17: *pl. 412*. 1902; Gilg in Fedde, Rep. Spec. Nov. 2: 52. 1906; Robinson in Gray's Manual, ed. 7. 659. 1908; Britton & Brown, Ill. Fl. 3: 15, *fig. 3365*. 1913; Gilg in Engl. Bot. Jahrb. 54: Beibl. 118, p. 93. 1916; Johnson, Tax. Fl. Pl. 488. *fig. 340*. 1931; Briquet in Candollea 4: 317. 1931; Rydberg, Fl. Cent. N. Am. 636. 1932.

Tetragonanthus Gmelin, Fl. Sib. 4: 114, *pl. 53*. 1769; Kuntze, Rev. Gen. Pl. 2: 431. 1891; Britton, Manual, 734. 1901; Small, Fl. Southeastern U. S. 931. 1913; Rydberg, Fl. Rocky Mts. 666. 1922.

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Ceratia Persoon, Syn. Pl. 1: 287. 1805; Hedw. Gen. 181. 1806.

Exadenus Grisebach, Obs. Gent. 36. 1836; Gen. & Sp. Gent. 322. 1839; in DC. Prodr. 9: 128. 1845.

Glabrous caulescent annual, biennial, or perennial herbs. Root fibrous, varying from typically herbaceous to extremely ligneous. Leaves membranaceous or fleshy, opposite, entire, sessile or petiolate, usually 3–5-veined, veins frequently submerged in fleshy type. Inflorescence a terminal or axillary, subumbellate, or rarely racemose or spicate cyme. Calyx 4-parted, foliaceous, linear, lanceolate, ovate or spatulate, usually papillate, often bearing small squamellae at the base of each lobe. Corolla 4-parted, white, yellow, green, or purple, marcescent, campanulate, the tube of varying length; the lobes dextrorsely convolute, elliptic to ovate, obtuse to acute or apiculate, entire, crisped or erose, frequently auriculate and papillate. Stamens

4, included, adnate to the corolla-tube at varying heights, and alternate with the corolla-lobes; filaments linear, occasionally somewhat dilated; anthers 2-celled, ovate, oblong or subtriangular, versatile. Carpels 2, sessile, the edges being infolded to form a parietal placenta bearing many ovules; stigma sessile, composed of two oblong or ovate lobes, the inner surfaces of which are stigmatic. Fruit a compressed capsule, lanceolate to ovate, often subfalcate, septicidially dehiscent from the tip. Seeds globose or slightly flattened, brown or greenish tan, granular or reticulate.

Type species: *H. corniculata* (L.) Druce in Rept. Bot. Exch. Cl. Brit. Isles **3**: 419. 1914.

Synopsis of the Sections of the Genus

Plants usually coarse with fleshy leaves, rarely slender with thin, herbaceous leaves; stem usually leafy; spurs absent, or present as very small inconspicuous protuberances, frequently obscured by calyx; distribution chiefly South America.....*1. Swertiella*

Plants usually slender, with thin, herbaceous leaves; stem leafy or scapose; spurs present; distribution North and South America.....*2. Haleniastrum*

Section 1. Swertiella

Key to North American Species and Varieties

1. Leaves mostly radical; stem more or less scapose.....*1. H. alata*
1. Leaves mostly cauline; stem not scapose.
  2. Leaves ovate, less than 1.2 cm. long.....*2f. H. brevicornis* var. *ovata*
  2. Leaves not ovate, longer than 1.2 cm.
    3. Pedicels filiform, slender, elongate; habit decidedly spreading.....*2g. H. brevicornis* var. *Tuerckheimii*
    3. Pedicels stouter than filiform, shorter.
      4. Corolla without distinct spurs.
        5. Inflorescence strict.....*2c. H. brevicornis* var. *micranthella*
        5. Inflorescence compact.
          6. Leaves linear, slender.....*2. H. brevicornis*
          6. Leaves ovate to lanceolate, coarse....*2a. H. brevicornis* var. *latifolia*
      4. Corolla with small, but distinct spurs.
        5. Spurs thick, conical, more or less pendulous.....*2b. H. brevicornis* var. *multiflora*
        5. Spurs blunt, spreading, squarrose...*2e. H. brevicornis* var. *chihuahuensis*
        5. Spurs slender, divergent.....*2d. H. brevicornis* var. *divergens*

1. H. alata (Mart. & Gal.) Hemsl. Biol. Cent.-Am. Bot. **2**: 351. 1882.

Exadenus alatus Mart. & Gal. Bull. Acad. Brux. **11**[1]: 372. 1844; Walper's Rep. Bot. Syst. **6**: 508. 1846–7.

Tetragonanthus alatus Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Small perennial with 1–2 simple erect slightly winged stems, about 0.5–1 dm. high; numerous radical leaves, up to 3.5 cm. long and .4 cm. broad, crowded, attenuate into long petioles, oblanceolate, obtuse, 3-nerved; lower cauline leaves almost twice the length of the radical, subsessile; upper linear, obtuse, sessile; inflorescence consisting of a few (4–6) terminal flowers on 4-winged pedicels; calyx foliaceous, slightly shorter than corolla, segments oblong, 3-nerved, papillate, acute; corolla yellow, subrotate, up to .6 cm. long, tube about one-half as long as the entire corolla; corolla-lobes ovate, obtuse; filaments linear; anthers ovate; capsule broadly ovate; seeds yellow-brown, globose, granular.

Distribution: rocky forests of southern Mexico.

Specimens examined:

Vera Cruz: in forests and on trachytic rocks on Mt. Orizaba, alt. 2250–3000 m., June–Oct. 1840, *Galeotti 7221* (BG, B type, DH, K, V); Mt. Orizaba, alt. 3000–3125 m., Aug. 1838, *Linden 934* (DH, K).

2. H. brevicornis (HBK.) G. Don, Gen. Hist. **4**: 177. 1838; Wedd. Chlor. And. **2**: 77. 1859; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882; Gilg in Engler & Prantl, Nat. Pflanzenfam. **4**^{2}: 89. 1895.

Swertia brevicornis HBK. Nov. Gen. & Sp. Pl. **3**: 174. 1818.

S. parviflora HBK. Nov. Gen. & Sp. Pl. **3**: 174. 1818.

S. parviflora var. *α angustifolia* Sch. & Cham. in Linnaea **5**: 122. 1830.

S. cucullata Sessé & Mociño, Fl. Mex. 79. 1894.

Halenia parviflora G. Don, Gen. Hist. **4**: 177. 1838; Wedd Chlor. And. **2**: 77. 1859; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

H. paucifolia Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

H. erythraeoides Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 105. 1916.

Exadenus parviflorus Griseb. Gen. & Sp. Gent. 322. 1839.

E. brevicornis Griseb. *l. c.* 323.

E. paucifolius Mart. & Gal. Bull. Acad. Brux. **11**^{1}: 372. 1844.

Tetragonanthus paucifolius Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

T. parviflorus Kuntze, *l. c.*

T. brevicornis Kuntze, *l. c.*

Annual, 1.5–4.5 dm. high; root slender; stems erect, slender, usually simple below and branched above, sometimes branched from the base, slightly angled, and striate; leaves sessile, subconnate, lower linear to lanceolate, up to 3 cm. long, .4 cm. broad, usually prominently uninerviate, upper shorter, narrower, up to 2 cm. long, linear; inflorescence compact cymose clusters, pedicels erect, 1.8 cm. or less in length; calyx-segments lanceolate, approximately one-half to two-thirds the length of the corolla, usually 3-nerved; corolla .4–.8 cm. long, tube one-half or slightly more the length of the entire corolla; corolla-lobes broadly to narrowly ovate, acute, more or less auriculate; spurs merely small depressions near the base of the corolla-tube, usually not visible to the naked eye; stamens about .2 cm. long, attached usually near the middle of the tube; filaments linear, anthers usually deltoid; ovary lanceolate, about .5 cm. long; seeds minute, ovoid to subglobose, brownish, finely reticulate.

Distribution: chiefly in mountains, from Mexico, southward to Peru.

Specimens examined:

MEXICO:

SAN LUIS POTOSI: Oct. 1879, *Schaffner 421* (BG, BM, F, NY, UC, US); region of San Luis Potosi, alt. 1500–2000 m., 1878, *Parry & Palmer 600* (ANSP, BM, F, G, IAC, K, M, NY, US).

VERA CRUZ: Mt. Orizaba, alt. 1875 m., 1841–43, *Liebmann 10775* (UC); same locality and date, alt. 2500 m., *Liebmann 10778* (UC); same locality, 1840, *Galeotti 7219* (B TYPE of *Exadenus paucifolius*, DH); "in dumetis prope Jalapam," 1830, *Schiede & Deppe 247a* (BG TYPE of *Swertia parviflora* var. α *angustifolia*, BM, M).

GUANAJUATO: near city Guanajuato, alt. 1650 m., *Humboldt & Bonpland* (BG TYPE not seen, HJP, M photo.).

PUEBLA: vicinity of Puebla, ravines, Hacienda Alamos, route Vera Cruz, alt. 2170 m., Nov. 5, 1907, *Arsène 2098* (G, M, US); mountains, Esperanza, Aug. 1907, *Purpus 2697* (BG, BM, CAS, F, M, US); Chinantha, alt. 1750–2000 m., May 1841, *Liebmann 10776* (NY, UC).

MEXICO: La Cima, alt. 2500 m., "Jajalpa," alt. 1500 m., Aug. 1904, *Kuntze 23783* (NY); Volcan de Toluca, *Heller 401* (V).

CHIAPAS: 1864–70, *Ghiesbreght 137* (G, K, NY); *Ghiesbreght 618* (G, K, M).

MEXICO WITHOUT LOCALITY: *Tate* (DH); Oct. 8, 1897, *Berlandier 1207 ex 13* (DH); *Berlandier 1207* (V); *Pavon* (DH); *Wawra 425* (V).

CENTRAL AMERICA:

COSTA RICA: "in monte Reventado," alt. 2250 m., coll. of 1847, *Oersted 10779* (UC).

NICARAGUA: El Viejo, *Oersted* (M).

2a. H. brevicornis var. **latifolia** (Sch. & Cham.) Allen, n. comb.

Swertia parviflora var. *β latifolia* Sch. & Cham. in Linnaea **5**: 122. 1830.

Exadenus parviflorus var. *β latifolius* Griseb. Gen. & Sp. Gent. 322. 1839; in DC. Prodr. **9**: 128. 1845.

Halenia parviflora var. *latifolia* Hemsl. Biol. Cent.-Am. Bot. **2**: 351. 1882.

A more sturdy plant than the species, attaining a height of 6 dm.; leaves larger than species, 1.5–4 cm. long, .3–1.5 cm. broad, acute or obtuse, lowermost smaller, ovate, rotund, and with longer petioles; inflorescence frequently less compact than that of species and with longer pedicels; calyx-segments lanceolate, foliaceous, one-half to two-thirds the length of the corolla, papillate, 3-nerved; corolla .6–.8 cm. long, tube about equalling the ovate, frequently papillate, auriculate lobes; spurs short, consisting of very slight angular protrusions from the extreme base of the corolla-tube, giving the corolla a square appearance.

Distribution: mountains of Mexico.

Specimens examined:

Vera Cruz: "in dumetis prope Jalapam," 1830, *Schiede & Deppe 247b* (BG type of *Swertia parviflora* var. *β latifolia* Sch. & Cham., BM, M, S, V); same locality, coll. of 1833, *Beyrich* (S); region of Orizaba, Oct. 20, 1866, *Bourgeau 3126* (BG, B, K, S, UC, US).

Puebla: Manzanilla, alt. 2250 m., Nov. 24, 1908, *Arsène 1703* (B, US); Barrancas, Hacienda Alamos, route Vera Cruz, alt. 2170 m., Dec. 10, 1907, *Arsène* (M, US); Boca del Monte, alt. 2300 m., Nov. 16–19, 1907, *Arsène* (US).

Morelos: Lecima, Sierra de Ajusco, Aug. 18, 1896, *Harshberger 137* (ANSP, G, US).

Tlaxcala: Chiautempan, alt. 2250 m., Nov. 10, 1908, *Arsène 1711* (B, US).

Mexico: Ajusco Mountains, 1905, *Lemmon & Lemmon* (CAS); Valley of Mexico, *Lemmon* (CAS); Ixtaccihuatl, Jan. 1903, *Purpus* (CAS); Salto de Agua, Nov. 1905, *Purpus 1762* (CAS, F, G, M, US); Sierra de las Cruces, alt. 2375 m., Sept. 12, 1904, *Pringle 13120* (BG, F, G, K, S, UC, US); Eslava, *Salazar* (US); near Salazar, Sept. 14, 1903, *Rose & Painter 7026* (US); Désierto Viejo, near Mexico, Sept. 6, 1865, *Bourgeau 799* (BG, B, DH, G, K, NY, S, UC, US).

Michoacan: vicinity of Morelia, alt. 2500 m., Oct. 26, 1911, *Arsène 5610* (M, US).

Mexico without Locality: *Berlandier 1207* (DH); 1832, *Alaman* (DH).

2b. H. brevicornis var. **multiflora** (Benth.) Allen, n. comb.

Halenia multiflora Benth. Pl. Hartw. 24. 1839.

Plant more sturdy than the species, frequently branched above, rarely branched at the base, 4.5 dm. or less high; leaves up to 1.3–2.5 cm. long, .2–.9 cm. broad, obtuse or acute, ovate to

narrowly lanceolate, frequently faintly 3-nerved, midvein always prominent; inflorescence usually densely flowered, though compactness of arrangement varies; mature corolla with small thick rounded pendant spurs at its base.

Distribution: in mountains of Mexico.

Specimens examined:

San Luis Potosi: in mountains of San Miquelito, Aug. 1877, *Schaffner 88* (G); Alvarez, Sept. 28–Oct. 3, 1902, *Palmer 160* (CAS, F, G, M, NY, UC, US); *Parry & Palmer 600b* (IAC, M).

Zacatecas: on the Sierra de los Morones, near Plateado, Sept. 1, 1897, *Rose 2732* (US).

Jalisco: "in pinetis Bolaños," 1839, *Hartweg 210* (BM, DH, G, K, NY, V); Sierra Madre, west of Bolaños, Sept. 15–17, 1897, *Rose 2962* (US); banks of ravines near Guadalajara, alt. 1250 m., Oct. 21, 1903, *Pringle 11636* (BG, F, G, K, US); hills near Guadalajara, Oct. 14, 1889, *Pringle 2735* (C, IAC); Rio Blanco, Oct. 1886, *Palmer 680* (G, NY, US); same locality and date, *Palmer 683* (G).

Guerrero: between Ajusinapa and Petatlan, alt. 1250–1750 m., Dec. 14, 1894, *Nelson 2126* (US).

Oaxaca: Sierra de San Felipe, alt. 2000 m., Oct. 13, 1894, *Smith 665a* (M, NY, US); same locality, alt. 1800 m., Aug. 15, 1898, *Conzatti & Gonzalez 878* (G); San Pedro Nolasco, alt. 1875 m., Oct. 1840, *Galeotti 1490* (B, DH).

2c. H. brevicornis var. **micranthella** (Briq.) Allen, n. comb.

Halenia micranthella Briq. in Candollea **4**: 320. 1931.

Plant 1.5–6 dm. high; leaves linear-lanceolate, often obtuse, 3-nerved, the lower long-petiolate, the upper linear, sessile; inflorescence usually less compact, but more strict, than in the species, and the stem and pedicels more erect; the nodes of the inflorescence approximately equidistant, giving the appearance of a narrow raceme; corolla campanulate, but more narrowed at the base than in the species; calyx-segments usually one-half the length of the corolla; corolla-lobes broadly ovate, acuminate, auriculate; spurs reduced to minute depressions, frequently not visible to the naked eye; anthers usually broadly ovate; filaments varying, usually linear, rarely dilated.

Distribution: mountains of Mexico.

Specimens examined:

Hidalgo: El Chico, near Pachuca, Sept. 1905, *Purpus 1761* (CAS, F, G, M, NY, US); wet meadows, Sierra de Pachuca, alt. 2450 m., Aug. 13, 1898, *Pringle 6964* (ANSP, BG, B, CAS, DH, F, G, IAC, K, M, NY, S, US, V); same locality, Sept. 8, 1899, *Pringle 7943* (BG, F, G, K, M, NY).

Mexico: Sierra de Ajusco, Nov. 9, 1903, *Pringle 11842* (BG, F, G, K, S, UC, US); near Ozumba, alt. 2000 m., Nov. 3, 1902, *Pringle 11329* (G, UC, US).

South Mexico without Locality: July 1841, *Liebmann 10777* (UC).

Briquet based his new species on *Pringle 6964*. This is cited in the original publication as *1964*, but this is merely a typographical error. The Pringle specimens are about 12 cm. high. The additional material cited above undoubtedly belongs to the same species based on *Pringle 6964*, but for the most part it consists of plants over 15 cm. in height.

It is possible that there are two distinct plants under *Purpus 1761*, but since the variation in the *brevicornis* complex, as a whole, is so pronounced, these differences have been considered as variations typical of the variety. Hence, all sheets of *Purpus 1761* have been determined as var. *micranthella*.

2d. H. brevicornis var. **divergens**[46] Allen, n. var.

Similar to var. *multiflora* but with more slender spurs which diverge, making the corolla broader at the base than at the tip.

Distribution: central Mexico.

Specimens examined:

MICHOACAN: Loma Sta. Maria, vicinity of Morelia, alt. 2000 m., Sept. 4, 1910, *Arsène 55* (F); vicinity of Morelia, near La Huerta, alt. 1950 m., Sept. 1, 1910, *Arsène* (M TYPE, US); Loma Sta. Maria, alt. 2050 m., Sept. 19, 1910, *Arsène* (M, US); same locality, alt. 1950 m., Sept. 4, 1910, *Arsène 5957* (K, M, S, US); same locality, Oct. 28, 1910, *Arsène 5864* (K, M, US).

VERA CRUZ: Orizaba, 1853, *Müller* (NY).

MEXICO WITHOUT LOCALITY: 1858, *Sumichrast* (DH).

2e. H. brevicornis var. **chihuahuensis**[47] Allen, n. var.

Similar to var. *multiflora* but with lower leaves always elliptic-ovate, about 1 cm. long, increasing in length and acuteness and decreasing in width as they approach the summit of the stem; inflorescence more loosely arranged, and spurs more blunt but not quite so pronounced as in *multiflora;* calyx-segments three-fourths the length of the corolla, and usually narrower.

[46] **H. brevicornis** var. **divergens** Allen, var. nov.—Differt a var. *multiflora* calcaribus tenuioribus divergentibus latioribus basi quam summo.—MICHOACAN: vicinity of Morelia, near La Huerta, alt. 1950 m., Sept. 1, 1910, *Arsène* (M TYPE, US).

[47] **H. brevicornis** var. **chihuahuensis** Allen, var. nov.—Differt a var. *multiflora* foliis inferioribus semper elliptico-ovatis ca. 1 cm. longis, prope summum caulis longitudine augmentibus et latitudine deminuentibus; inflorescentia laxiora; calcaribus obtusis; calycis segmentibus ¾ corollae longitudini adaequantibus, plerumque angustioribus.—CHIHUAHUA: pine plains, base of the Sierra Madre, Sept. 26, 1888, *Pringle 1664* (BG, BM, B, CAS, DH, M TYPE, S, V).

Distribution: mountains of Chihuahua, Mexico.
Specimens examined:
CHIHUAHUA: pine plains, base of the Sierra Madre, Oct. 4, 1887, *Pringle 1330* (ANSP, CAS, F, G, K, NY, US); same locality, Sept. 26, 1888, *Pringle 1664* (BG, BM, B, CAS, DH, M TYPE, S, V); mesa, west of Hop Valley, Sierra Madre Mountains, alt. 1750 m., Sept. 17, 1903, *Jones* (BM, M, US); southwestern Chihuahua, Aug.–Nov., 1885, *Palmer 403* (ANSP, G, IAC, K, NY, US).

2f. H. brevicornis var. **ovata**[48] Allen, n. var.

Plant 5–6 dm. high; stems erect, simple below, bearing short floriferous branches only at tip; leaves about 12 pairs, shortly petiolate, frequently bearing buds in the axis; lower leaves broadly ovate, usually with a prominent midvein, reticulate, less than .5 cm. long, .3–.4 cm. broad, abruptly acuminate; middle cauline leaves ovate, 1–1.2 cm. long, .7–.8 cm. broad, acuminate; upper leaves up to 1.5 cm. long, lanceolate; inflorescence and flowers similar to *multiflora* type, but spurs more slender, slightly incurved, and divaricate.

Distribution: known only from type locality.
Specimens examined:
MEXICO: Tepic, Jan. 5–Feb. 6, 1892 *Palmer* (US TYPE).

2g. H. brevicornis var. **Tuerckheimii** (Briq.) Allen, n. comb.

Halenia Tuerkheimii Briq. in Candollea **4**: 317. 1931 (dedicated to H. von Tuerckheim).

Slender graceful stem, loosely branching, up to 6 dm. high; leaves lanceolate to linear-lanceolate or elliptic, about 1 cm. long, .5 cm. broad, lower cauline leaves becoming more acute, faintly 3-nerved, midvein prominent; middle cauline leaves 3 cm. or less long, .5 cm. broad; inflorescence in loose, terminal or axillary, few-flowered cymes, each flower borne on a long slender attenuate pedicel; first flowers with very small, though definitely formed, spurs, at the base of the corolla-tube; later and usually axillary flowers of more slender habit and without spurs.

[48] **H. brevicornis var. ovata** Allen, var. nov.—Planta 5–6 dm. alta; caulibus erectis, infra simplicibus modo summo ramos breves floriferos gerentibus; foliis ca. 12 geminis, breve petiolatis, saepe in axibus gemmas gerentibus; foliis inferioribus late ovatis, medio-nervo plerumque prominenti, reticulatis, minusquam .5 cm. longis, .3–.4 cm. latis, abrupte acuminatis, foliis mediis caulinis 1–1.2 cm. longis, .7–.8 cm. latis, ovatis, acuminatis; foliis superioribus usque ad 1.5 cm. longis, lanceolatis; inflorescentia et floribus *multiflorae* similibus sed calcaribus tenuioribus, parvulum incurvatis divaricatisque.—MEXICO: Tepic, Jan. 5–Feb. 6, 1892, *Palmer* (US TYPE).

Distribution: known only from type locality.

Specimens examined:

GUATEMALA: "Alta Verapaz, Fichtenwälder bei San Joaquin," alt. 1000 m., Dec. 1907, *von Tuerckheim 2041* (F, DH, G, NY, US, V).

From an examination of the types of *Halenia brevicornis*, *H. parviflora*, *H. multiflora*, and *Exadenus paucifolius*, etc., it appears that this group presents a complex, all members of which show variation in habit and spurs, which can not be considered specific differences but differences of degree. Careful perusal of the specimens available discloses the fact that nearly every locality produces some variation in the species. Thus, Chihuahua gives rise to a definitely spurred form, while Guatemalan material presents an entirely different aspect habitally. Ecological experiments, as well as field work, would doubtless prove highly valuable as a supplement to the taxonomic treatment of this complex. At present there is no distinction which warrants the retention of these as distinct entities. To draw a line between these forms mentioned and treat them specifically would complicate further an already confused situation. Therefore it has seemed advisable to draw attention to these differences, or variations from the specific form, by relegating them to the status of variety of form, with the note that this is merely an arbitrary disposal, that intergradation is existent and that environment is in a large measure responsible for the variation found within the species.

KEY TO THE SOUTH AMERICAN SPECIES

1. Leaves always thin, herbaceous; stem and branches more or less slender.
   2. Plant slender; flowers in anthesis less than 1 cm. long.
      3. Stem usually branched above, sparingly leafy; basal rosette absent... ..... *2. H. brevicornis*
      3. Stem not branched above, leafy; leaves adpressed; basal rosette present..... *3. H. adpressa*
   2. Plant coarse; flowers in anthesis usually more than 1 cm. long.
      3. Nodes 8 or less; leaves not apiculate..... *4. H. macrantha*
      3. Nodes 12 and more; leaves apiculate..... *5. H. Karstenii*
1. Leaves more or less fleshy; stem and branches coarse.
   2. Upper leaves of inflorescence subinvolucrate and bearing flowers..... ..... *6. H. subinvolucrata*
   2. Upper leaves of inflorescence not subinvolucrate.
      3. Rosette usually present; stem-leaves linear-lanceolate.
         4. Plant usually less than 30 cm. high; leaves not more than 5 cm. long.
            5. Calyx-lobes minutely hirtellous.

6. Plant usually less than 20 cm. high, or if more than 20 cm. high, flowers in axils of all cauline leaves.....*7. H. inaequalis*
6. Plant 10–30 cm. high; flowers in axils of upper leaves only.....*8. H. viridis*
5. Calyx-lobes not hirtellous.
6. Stem-leaves less than 3 pairs, linear.....*9. H. Schultzei*
6. Stem-leaves more than 3 pairs, lanceolate to linear-lanceolate.
7. Cauline leaves less than 2 cm. long.....*10. H. gentianoides*
7. Cauline leaves more than 2 cm. long.....*11. H. stellarioides*
4. Plant usually more than 30 cm. high; leaves more than 5 cm. long.
5. Inflorescence verticillate; leaves ternate.....*12. H. verticillata*
5. Inflorescence not verticillate; leaves not ternate.
6. Nodes more than 12.....*13. H. foliosa*
6. Nodes less than 12.
7. Root-stalk swollen, conspicuously larger than stem.
8. Flowers more than 1.5 cm. long, 8–10 mm. broad.....*14. H. dasyantha*
8. Flowers less than 1.3 cm. long, 5–7 mm. broad.....*15. H. elata*
7. Root-stalk not swollen, scarcely larger than stem.
8. Plant less than 30 cm. high.....*16. H. Tolimae*
8. Plant more than 30 cm. high.
9. Inflorescence elongate, spicate; calyx-venation conspicuous.....*17. H. hygrophila*
9. Inflorescence spreading; calyx-venation prominently ribbed.....*18. H. parallela*
3. Rosette absent; stem-leaves ovate to ovate-lanceolate.....*19. H. major*

2. Halenia brevicornis (HBK.) G. Don, Gen. Hist. **4**: 177. 1838.

For synonymy and description, see North American species, page 140 of this work.

Specimens examined:

SOUTH AMERICA:

VENEZUELA: Trujillo & Mérida, alt. 1300–4900 m., 1842, *Linden 456* (DH).

COLOMBIA: Bogota, Dec. 19, 1853, *Holton 19* (*464*) (NY); Dept. Cundinamarca, moist grassy loam, southwest of Sibate, alt. 2600–2800 m., Oct. 13–15, 1917, *Pennell 2434* (M, NY, US); Dept. Antioquia, La Sierra, Medellin, alt. 2000 m., Jan. 4, 1931, *Archer 1348* (M); Dept. El Cauca, open banks near Rio Cauca, Coconuco to Popayan, alt. 2000–2500 m., June 18, 1922, *Killip 6889* (US); field, near Rio San Andreas, Calaguala, Coconuco, alt. 2500–2800 m., June 18, 1922, *Pennell 7154* (ANSP, G, NY, US); field, north of Coconuco, alt. 2300–2500 m., June 11, 1922, *Pennell & Killip 6480* (ANSP).

ECUADOR: near Quito, coll. of 1859, *Jameson* (DH, G, NY, UC, V).

PERU: steep grassy slopes, Mito, alt. 3000 m., April 8–18, 1923, *Macbride 3431* (F, M); 1840, *Mathews 3133* (DH).

Attention should be called to the fact that the *Swertia brevicornis* of Humboldt, Bonpland & Kunth, which Gilg has relegated

to synonymy, is a very short much-branched specimen, differing markedly in habit from the *S. parviflora* HBK. A close examination of the type of the former reveals the fact that the terminal branch has been broken off. Subsequent lateral offshoots give an entirely different appearance habitally. This situation is apparent also in the specimens collected by Oersted in Central America, which Gilg in 1915 labeled *H. parviflora*.

3. H. adpressa[49] Allen, n. sp.

Perennial, .5–2.5 dm. high; root coarse; stem usually solitary, erect, slender; basal leaves in dense rosette, oblanceolate, 1–1.5 cm. long, .3 cm. broad; cauline leaves 5–6 pairs, sessile, lanceolate, 1–1.5 cm. long, .2–.3 cm. broad, acute; inflorescence a several-flowered cyme, pedicels 2 cm. long; calyx-lobes lanceolate, .4–.6 cm. long, .15 cm. broad, obsoletely 3-nerved, midvein prominent; corolla .7–.9 cm. long, yellow, tube slightly less than one-half the length of the entire corolla; lobes ovate, auriculate, papillate, apiculate; spurs thick or slender, pendulous, more or less divergent, giving the flower a triangular appearance just preceding anthesis; stamens approximately .4 cm. long; filaments linear, anthers oval; capsule lanceolate; seeds ovoid.

Distribution: known only from Colombia.

Specimens examined:

COLOMBIA: Dept. Santander, Páramo de las Vegas, alt. 3700–3800 m., Dec. 20–21, 1926, *Killip & Smith 15679* (M TYPE, NY, US).

Species very similar to *H. brevicornis*.

4. H. macrantha Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 105. 1916.

Perennial herb, 5–6 cm. high, with root curved-erect, ligneous,

[49] **H. adpressa** Allen, sp. nov.—Herba perennis, usque ad 2.5 dm. alta; radice crassa; caule plerumque solitario, erecto, tenui; foliis basalibus in rosula densa, oblanceolatis, 1.–1.5 cm. longis, .3 cm. latis; foliis caulinis 5–6 geminis, sessilibus, lanceolatis, 1–1.5 cm. longis, .2–.3 cm. latis, acutis; inflorescentia multiflorifera cyma, pedicellis 2 cm. longis; calycis lobis lanceolatis, .4–.6 cm. longis, .15 cm. latis, obsolete 3-nerviis, medio-nervo prominenti; corolla .7–.9 cm. longa, flava, tubo ½ totae corollae longitudini parum subaequanti; corollae lobis ovatis, auriculatis, papillatis, apiculatis; calcaribus crassis vel tenuibus, gibbis, pendulis, plus minusve divaricatis; staminibus ca. .4 cm. longis; filamentis linearibus, antheris ovalibus; capsula lanceolata; seminibus ovoideis.—COLOMBIA: Dept. Santander, Páramo de las Vegas, alt. 3700–3800 m., Dec. 20–21, 1926, *Killip & Smith 15679* (M TYPE, NY, US).

rather elongate, covered with the blackish remains of marcescent leaves; flowering stem single, erect, internodes 4–5 cm. long, with no rosette leaves before anthesis; leaves herbaceous, acute, 3-nerved veins sunken above, prominent below; lower cauline leaves oblanceolate, gradually narrowed into a long but broad petiole, 6–7 cm. long, .5–1.5 cm. broad; upper leaves lanceolate to ovate-lanceolate, broadly sessile, about 3 cm. long; inflorescence an apical 3-flowered cyme, solitary in axils of the uppermost euphylloid leaves; pedicels of apical flowers 3 cm. long, those of laterals 2 cm.; calyx-lobes oblanceolate, 1–1.3 cm. long, 3-nerved, acute; corolla about 1.5 cm. long, green, tube about one-third the length of the entire corolla; lobes ovate to broadly ovate, very acute, somewhat apiculate; spurs large, globose, conical, calluses about .3 cm. long at the base of the tube.

Distribution: Colombia.

No specimens examined, but description compiled from original publication. (TYPE, *Kalbreyer 702*, BG).

5. **H. Karstenii** Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 105. 1916.

Biennial or perennial herb up to 5 dm. high; root branched; stems simple, covered with leaf-bases for 7–8 cm. at intervals of less than .4 cm., internodes up to 4–5 cm. long; leaves in pairs at the nodes, sessile, lanceolate, narrowed at base, 2–5.5 cm. long, up to .9 cm. broad, 3-nerved, veins excurrent, forming a mucro; inflorescence 4–12 flowers in terminal and axillary cymes, pedicels erect, up to 4 cm. long; calyx-lobes lanceolate, .6–.8 cm. long, .2–.25 cm. broad, acuminate, 3-nerved, papillate; corolla about 1 cm. long, tube not quite one-half the length of the entire corolla; lobes ovate, subrotund, erose at apex; spurs midway up the corolla tube, small, scarcely noticeable, glandular convex depressions in the corolla; stamens about .3 cm. long, at the orifice of the tube; filaments linear, anthers oval, acute; capsule 15–18 cm. long, ovate; seeds ovoid, light brown, wrinkled.

Distribution: páramos of Bogota.

Specimens examined:

COLOMBIA: Páramo de Bogota, *Karsten* (V TYPE).

6. **H. subinvolucrata** Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 99. 1916.

Perennial herb, about 2 dm. high; root multifibrous; subterranean stem vertical, short, thick, flowering stem erect, loosely leafy; leaves thickly herbaceous or somewhat fleshy, 3-nerved, veins sub-parallel, deeply sunken above, prominent below; basal leaves linear-lanceolate, gradually narrowed at the base into narrow petiole, 4–5 cm. long, .4–.5 cm. broad; lower cauline leaves similar to basal leaves; upper cauline leaves broadly sessile, lanceolate or lanceolate-ovate to ovate, 2–4 cm. long, .6–1 cm. broad; inflorescence terminal or axillary, almost sessile 3-flowered cymes, peduncles .3–.6 cm. long; floral leaves sheathing inflorescence and longer than flowers; calyx-lobes oblong-ovate, about 1 cm. long, up to .3 cm. broad, 5-nerved, minutely hirtellous, acute; corolla about 1 cm. long, tube about one-third or less the length of the entire corolla; lobes oblong-ovate, .7 cm. long, .3–.35 cm. broad, subrotund, erose at apex; spurs scarcely prominent blackish maculations at the base of the tube; stamens about .2 cm. long; anthers ovate-oblong; filaments linear.

Distribution: Venezuela.

Specimens examined:

VENEZUELA: high mountains of Trujillo and Mérida, alt. 1300–4900 m., 1842, *Linden 437* (DH TYPE).

7. H. inaequalis Wedd. Chlor. And. **2**: 78. *pl. 53 C.* 1859; Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 99. 1916.

Herb 1.5–2(–3) dm. high; stem solitary, erect, loosely leafy, with internodes about 4–5 cm. long, and inflorescence comprising the upper third of the stem, or stem short, leafy, with internodes equidistant, 1–2 cm. long, arising in axil of every leaf; radical leaves petiolate, lanceolate to oblanceolate, 2–3 cm. long; upper cauline leaves sessile, lanceolate to elliptic, minutely hirtellous; flowers disposed in small loose pedunculate cymules; peduncles erect or slightly nodding, 1–2 cm. long; calyx-lobes lanceolate or oblong-lanceolate, acute, margin minutely hirtellous; corolla scarcely 1 cm. long, exceeding the calyx by one-fourth its length; lobes ovate, acute; spurs inconspicuous.

Distribution: known only from Venezuela.

Specimens examined:

VENEZUELA: Páramo de Timotes, Mérida, alt. 3800 m., Sept. 4, 1921, *Jahn 558* (HP, US); same locality, alt. 3600 m., Jan. 21, 1922, *Jahn 839* (HP, US); Mérida, alt. 3000 m., 1846, *Funck & Schlim 901* (DH TYPE).

Funck & Schlim 1148 is cited by Weddell in the original publication of the species, but Gilg has placed this number under *H. viridis*.

8. H. viridis (Griseb.) Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 100. 1916.

Gentiana viridis Griseb. in Linnaea **22**: 43. 1849; Wedd. Chlor. And. **2**: 62. 1859.

H. inaequalis Wedd. Chlor. And. **2**: 78. 1859; Gilg, *l. c.*

Perennial herb, 1–3 dm. high; stem solitary, erect, thick, simple, internodes 4–5 cm. long; basal leaves in rosette, more or less coriaceous, sessile, lanceolate, subequal, up to 6 cm. long, .4 cm. broad, minutely hirtellous, 3-nerved; cauline leaves 3–4 pairs, approximately 5 cm. long; inflorescence a narrow racemiform cyme arising in the middle of the stem, with simple 3–5-flowered cymules; pedicels erect before anthesis, cernuous after, about 2.5 cm. or less long; calyx-lobes oblong-lanceolate, minutely hirtellous, about .4–.5 cm. long, nerved; corolla about 1 cm. long, greenish, tube about one-third the length of the entire corolla; lobes elliptic-lanceolate, rather obtuse, somewhat erose at apex; spurs inconspicuous; stamens .5 cm. long; anthers ovate; capsule oblong-lanceolate.

Distribution: known only from Venezuela.

Specimens examined:

VENEZUELA: Sierra Nevada, Mérida, alt. 3300 m., 1846, *Funck & Schlim 1148* (DH TYPE); Laguna Mucuy, Cabeceras del Saisay, Mérida, 4200–4300 m., April 19, 1930, *Gehriger 92a* (HP).

9. H. Schultzei[50] Gilg, n. sp.

Caespitose mat-like perennial, about 3 dm. high; root tough, fibrous; stems one or more, erect, simple, slender, internodes 5–7

[50] **H. Schultzei** Gilg, sp. nov.—Herba perennis, caespitosa, ca. 3 dm. alta; radice lenta, fibrata; caulibus 1–multis, simplicibus, tenuibus, internodiis 5–7 cm. longis; foliis basalibus in rosula densa, in petiolis longis tenuibus attenuatis, ad basin dilatatis, lineari-lanceolatis, ca. 5 cm. longis, .5 cm. latis, nerviis, acutis; foliis caulinis plerumque 2 geminis, sessilibus, linearibus, plerumque ca. 1.5 cm. longis, nerviis, acutis; inflorescentia pauco-florifera cymis terminalibus lateralibusque, pedicellis tenuibus, 1–1.5 cm. longis, ad apicem recurvatis; calycis lobis lanceolatis, ca. .6 cm. longis, acutis; corolla latissime campanulata, ca. 1.3 cm. longa, flava; corollae lobis ovatis, obtusis, marginibus erosis vel crispis; calcaribus inconspicuis.—(TYPE, *Schultze 1304*, BG).

cm. long; basal leaves in dense rosette, narrowed into long slender petioles, dilated at base, linear-lanceolate, about 5 cm. long, .5 cm. broad, nerved, acute; stem-leaves usually 2 pairs, sessile, linear, usually about 1.5 cm. long, nerved, acute; inflorescence few-flowered in terminal and lateral cymes, pedicels slender, 1–1.5 cm. long, recurved at tip; calyx-lobes lanceolate, about .6 cm. long, acute; corolla very broadly campanulate, about 1.3 cm. long, yellow; corolla-lobes ovate, rather obtuse, erose or crisped margins; spurs not discernible.

Distribution: Colombia.

No specimens examined, but description compiled from photograph. (TYPE, *Schultze 1304*, BG).

10. H. gentianoides Wedd. Chlor. And. **2**: 78. *pl. 53B.* 1859.

Perennial herb, up to 3 dm. high; root more or less thick, ligneous; stems sterile or flowering, long, loosely leafy; basal leaves in a dense rosette, petiolate; cauline leaves 2–6 pairs, subsessile, lanceolate, acute, 3-nerved; inflorescence lateral or terminal, small racemiform cymes, peduncles more or less resupinate; calyx-lobes oblong, up to .7 cm. long, papillate, acuminate, prominently 3-nerved; corolla about 1 cm. long, tube approximately one-third the length of the entire corolla; lobes ovate, rotund, crenulate-erose; spurs reduced to inconspicuous glandular areas not visible to the naked eye; stamens approximately .4 cm. long; filaments linear, anthers ovate, acuminate; capsule lanceolate.

Distribution: páramos of Colombia.

Specimens examined:

COLOMBIA: Páramo de Bogota, *Karsten* (V); same locality, *Goudot* (BG TYPE, M photo, V); same locality, *Triana 1964* (DH, V); same locality, Jan. 17, 1854, *Holton 467* (DH, G); Guasca, 1919, *Ariste-Joseph A423* (US).

11. H. stellarioides Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 100. 1916.

Perennial? herb, up to 3 dm. high; flowering stem erect, loosely leafy, internodes 4–7 cm. long; basal leaves lacking; cauline leaves sessile, lanceolate to linear-lanceolate, 2.5–3.5 cm. long, gradually decreasing toward the summit, .4–.5 cm. broad, acute, 3-nerved; inflorescence lateral or terminal, 5–7-flowered cymes, pedicels more or less erect, up to 1.5 cm. long; calyx-lobes lance-

olate or oblong-lanceolate, about .8 cm. long, .25 cm. broad, acute, 3-nerved, or nerves obsolete; corolla about 1 cm. long, tube about one-third the length of the entire corolla; lobes ovate-oblong, upper margin subcrenulate, acute; spurs semi-globose callous prominences at the base of the tube.

Distribution: páramos of Colombia.

No specimens examined, but description compiled from original publication and photograph. (TYPE, *Lehmann 3080*, BG).

12. H. verticillata Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 103. 1916.

Annual herb, slender, up to 1 m. high; root fibrous; stem .5 cm. thick, becoming black, covered with the remains of early leaves, densely leafy at the middle or just below the middle of the stem, internodes up to 8 cm. long; basal leaves in dense whorls for a varying distance up the stem, connate, sessile, linear-lanceolate, 10 cm. or less long, .8 cm. broad, acuminate, 5-nerved, fleshy; cauline leaves in 7–8 whorls of 3, lanceolate (extreme upper subtending inflorescence, ovate-lanceolate), 5-nerved, 5–6 cm. long, gradually decreasing in length toward the summit, with corresponding increase in width; flowers numerous, disposed in 3–5 verticillate, axillary and terminal cymose clusters; pedicels erect, up to 3.5 cm. long; calyx-lobes oblong-lanceolate, papillate on under surface of veins and entire upper tip, up to 1.0 cm. long, .2–.35 cm. broad, acuminate to acute, 5-nerved, veins parallel, becoming confluent at tip; corolla apple-green or yellowish-green, up to 1.7 cm. long, tube about one-third the length of the entire corolla; lobes broadly ovate, subrotund, erose and papillate at tip; spurs subglobose glandular prominences at the base of the corolla.

Distribution: wet páramos about volcanos, Colombia.

Specimens examined:

COLOMBIA: "Cauca am Vulkan," Sotará, 3500 m., *Lehmann 6190* (BG TYPE, F); Dept. of El Cauca, Mt. Pan de Azucar, alt. 3500–3700 m., June 16, 1922, *Pennell 7052* (ANSP, G, NY, S, US).

13. H. foliosa Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 101. 1916.

Biennial herb (?), up to 8 dm. high; root stout (?); flowering stems 1–many, erect, simple, few or no leaves at base, lower internodes 1–1.5 cm. long, upper 5–7 cm. long; numerous pairs

of lower cauline leaves, thickly herbaceous, gradually narrowed toward the base but dilated again at base, lanceolate, 3–5 cm. long, about 1 cm. broad, acute, 3–5 nerved; upper cauline leaves herbaceous, gradually narrowed toward the base and broadly sessile, ovate-elliptic, 3–5 cm. long, about 1 cm. broad, acute to very acute, 5-nerved, veins parallel, sunken above, prominent below; terminal and axillary, loosely arranged, many-flowered elongate cymes, comprising a thyrsoid inflorescence 10 cm. long, pedicels about 2.5 cm. long; small upper leaves shorter than the inflorescence; calyx-lobes ovate-oblong, .7–.8 cm. long, .3 cm. broad, acute or very acute, 3-nerved; corolla about 1.3 cm. long, tube about one-fourth the length of the entire corolla; spurs semi-globose protuberances at the base of the tube.

Distribution: páramos of Colómbia.

Specimens examined:

COLOMBIA: Dept. of Bolivar-Antioquia, Páramo de Chaquiro, alt. 3000–3200 m., Feb. 23, 1918, *Pennell 4268* (NY, US). (TYPE not seen, *Stübel 276*, BG, M photo).

14. H. dasyantha Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 103. 1916.

Perennial herb, (1.5–)3–7 dm. high; root thick; stem erect, simple, more than .5 cm. thick, fleshy, brown in dried specimens, faintly striate, covered with remains of marcescent leaves, 2–5 internodes up to 10 cm. long; basal leaves in a dense rosette, broadly elliptic, up to 10 cm. long, nearly 2 cm. broad, acute, 5-nerved; 3–5 pairs of cauline leaves, sessile, dilated at base, oblong-lanceolate, 4–10 cm. long, their length gradually decreasing toward the summit, 1–2 cm. broad, acute, 5-nerved; inflorescence axillary and terminal, many-flowered racemose cymes, usually 10 cm. long; pedicels erect, for most part up to 3.5 cm. long; calyx-lobes ovate to ovate-lanceolate, papillate, up to 1 cm. long, .4–.5 cm. broad, acute to abruptly acuminate, 3-nerved; squamellae frequently scale-like lobed bodies; corolla 1.5–2 cm. long, pale greenish-yellow, tube nearly equal in length to the entire corolla; lobes ovate, subrotund, erose at apex, somewhat papillate; spurs small subglobose prominences at the base of the corolla-lobes, almost obscured by the calyx; stamens approximately .4 cm. long, attached at the summit of the tube; filaments linear, anthers ovate-oval; stigma reflexed; capsule up to 2 cm. long; seeds elliptical, reticulate.

Distribution: moist grassy páramos, or dry open woods, Colombia.

Specimens examined:

COLOMBIA: Dept. of Caldas, Páramo del Quindio, alt. 3700–4200 m., Aug. 15–20, 1922, *Pennell & Hazen 9997* (ANSP, NY, US); Dept. of Tolima, Páramo de Ruiz, alt. 3500–3800 m., Dec. 16–17, 1917, *Pennell 3001* (NY, M, US); Dept. of Cauca, Páramo de Buena Vista, Huila group, Central Cordillera, alt. 3000–3600 m., Jan. 1906, *Pittier 1111* (US). (TYPE not seen, *Lehmann 2065*, BG, M photo.).

This species is very similar to *H. elata* but is, on the whole, a larger and coarser plant. Since the material is scanty and the geographical location different, *H. dasyantha* has for the present been maintained as a distinct species.

15. H. elata Wedd. Chlor. And. **2:** 78. 1859.

Perennial, up to 5 dm. high; stem thick, coarse, erect, loosely leafy; numerous basal leaves in dense rosette, broadly lanceolate, attenuate into petiole, dilated at base, 7–10 cm. long, approximately 1 cm. broad, 5-nerved, acuminate; cauline leaves more or less sessile, shorter, lanceolate, acute; inflorescence numerous loose terminal and lateral cymes, peduncles up to 3 cm. long; calyx-lobes oblong-lanceolate to ovate-lanceolate, .7–.8 cm. long, 3-nerved, papillate, acute; corolla hardly one-fourth more than the length of the calyx, tube slightly more than one-half the length of the entire corolla; lobes ovate, obtuse; spurs inconspicuous tubercules at the extreme base of the corolla; stamens .6 cm. long; anthers narrowly ovate, filaments linear.

Distribution: in the Sierra Nevada of Santa Marta, Venezuela.

Specimens examined:

VENEZUELA: Sierra Nevada de Santa Marta, Caracas, 1844, *Funck 415* (DH TYPE).

16. H. Tolimae Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 101. 1916.

Perennial herb, 2.5–3 dm. high; root thick; root-stalk thick, densely covered with remains of marcescent leaves; one to few flowering stems, thick, erect, simple for the most part, very narrowly winged, internodes 3–6 cm. long; basal leaves arranged in rosette, slightly narrowed into long broad petioles, dilated at the base, lanceolate, 5–8 cm. long, up to .5–.6 cm. broad, 3–5-nerved, acute; stem-leaves 2–3 at a node, sessile, broadly lanceolate, 4–6 cm. long, .6–.7 cm. broad, their size gradually decreasing toward the summit, 3–5 subparallel veins, sunken above,

prominent below, reticulate; inflorescence few-flowered (5–7) cymes, axillary and terminal; pedicels more or less resupinate, up to 3 cm. long, the central one longer; calyx-lobes ovate to ovate-oblong, papillate, .7–.9 cm. long, .25–.35 cm. broad, subacuminate, 3-nerved; corolla up to 1.3 cm. long, light greenish-yellow, tube slightly less than one-third the length of the entire corolla; lobes ovate, erose and papillate at the tip; spurs glandular subglobose protuberances at the base of the tube, obscured by the calyx; stamens approximately .4 cm. long; filaments linear, anthers ovate; capsule lanceolate, apiculate, 2 cm. long; seed ovoid-elliptical, very minutely reticulate, pale tan.

Distribution: grassy páramos of Colombia.

Specimens examined:

Colombia: Dept. of Caldas, Páramo del Quindio, alt. 4100–4400 m., Aug. 15-20, 1922, *Pennell & Hazen 9841* (ANSP, G, NY, US); (type not seen, *Stübel 228*, BG, M photo.); bare loam slopes below snow, same locality and date, alt. 4300–4500 m., *Pennell & Hazen 9894* (ANSP, NY, S, US).

This last-cited specimen has leaves broader than those of the type, but is similar otherwise. *H. Tolimae* appears to be closely related to *H. elata*.

17. H. hygrophila Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 102. 1916.

Biennial herb, about 6 dm. high; root ligneous; subterranean root-stalk covered with darkened leaf-bases; flowering stem fleshy, erect, simple, 1 cm. thick, faintly winged, internodes up to 8 cm. long; 30–40 basal leaves in a dense rosette, linear, up to 12 cm. long, .5–.9 cm. broad, acute, 5-nerved; cauline leaves yellow-green, 3–4 pairs, the lower lanceolate, the upper subtending the inflorescences, ovate-lanceolate, sessile, 5–7 cm. long, gradually decreasing in size toward the summit, approximately .8–1.2 cm. broad, 7-nerved, parallel veins confluent at tip; inflorescence terminal and axillary in upper stem-leaves, in dense many-flowered cymes, giving spicate appearance, pedicels erect, up to 3 cm. long; calyx-lobes ovate-oblong to ovate, papillate, .9–1.0 cm. long, narrowly acute, 5-nerved, reticulate; corolla up to 1.5 cm. long, yellowish-green, tube approximately one-third the length of the entire corolla; lobes ovate, erose at apex; spurs angular sac-like prominences at the extreme base of the corolla lobes, obscured by calyx; stamens approximately .7 cm. long, attached at the orifice of the tube; filaments linear,

anthers broadly oblong, apiculate; capsule lanceolate; seeds elliptic, pale tan, reticulate.

Distribution: páramos of Andes, Colombia.

Specimens examined:

COLOMBIA: Páramo of Guanacas, Central Andes of Popayan, 3000–3600 m., *Lehmann 7860* (F, G, BG TYPE, M photo, US).

18. H. parallela[51] Allen, n. sp.

Perennial herb, up to 6 dm. high; root-stalk thick; flowering stem single, erect, simple, or branched above, striate, lower internodes 1–1.5 cm. long, upper 4–6 cm. long; numerous basal leaves in rosette, almost sheathing, lanceolate, 3–5-nerved, about 9 cm. long, 1 cm. broad; cauline leaves about twelve pairs, more remote toward the apex, sessile, lanceolate to elliptic, 4–6 cm. long, gradually decreasing toward the summit, approximately 1 cm. broad, 3–5 subparallel veins sunken above, prominent below; inflorescence 1 or more many-flowered axillary and terminal cymes, pedicels more or less erect, up to 3.5 cm. long, the lateral somewhat shorter than the terminal; calyx-lobes ovate, papillate, .7–.9 cm. long, .4 cm. broad, attenuately acute, prominently 5–7-nerved, veins subparallel; corolla about 1.3 cm. long, probably greenish?, tube about one-fourth the length of the entire corolla; lobes broadly ovate, slightly papillate, crisped toward the tip, abruptly acuminate; spurs large globose protuberances at the base of the tube, obscured by calyx; stamens nearly .5 cm. long, attached at the orifice of the tube; filaments linear, anthers oblong; capsule lanceolate.

[51] **H. parallela** Allen, sp. nov.—Herba perennis, usque ad 6 dm. alta; radice crassa; caule florifero solitario, erecto, simplice vel supra ramoso, striato; internodiis inferioribus 1–1.5 cm. longis, superioribus 4–6 cm. longis; foliis basalibus multis, in rosula densa, fere vaginantibus, lanceolatis, 3–5-nerviis, ca. 9 cm. longis, 1 cm. latis; foliis caulinis ca. duodecem geminis, ad apicem remotioribus, sessilibus, lanceolatis vel ellipticis, 4–6 cm. longis, sensim sursum decrescentibus, ca. 1 cm. latis, 3–5-nerviis, nervis subparallelis, supra immersis, infra prominentibus; inflorescentia cymis 1- vel pluro-floriferis axillaribus et terminalibus; pedicellis plus minusve erectis, usque ad 3.5 cm. longis, lateralibus terminalibus brevioribus; calycis lobis ovatis, papillatis, .7–.9 cm. longis, .4 cm. latis, attenuate acutis, prominente 5–7-nerviis, nervis subparallelis; corolla ca. 1.3 cm. longa, forte viridula, tubo ca. ¼ totae corollae longitudini adaequanti; lobis late ovatis, parum papillatis, ad apicem crispis abrupte acuminatis; calcaribus magnis globosis gibbis ad basin tubi calyce obscuratis; staminibus ca. .5 cm. longis, tubi summo adjunctis; filamentis linearibus, antheris oblongis; capsula lanceolata.—VENEZUELA: Páramo de La Negra, Mérida, Dec. 1927, *Gutzwiller 32* (HP TYPE, US).

Distribution: Venezuela.

Specimens examined:

Venezuela: Páramo de La Negra, Mérida, Dec. 1927, *Gutzwiller 32* (HP type, US).

Species near *H. foliosa* and *H. hygrophila*.

19. H. major Wedd. Chlor. And. 2: 79. 1859.

Annual probably, up to 6 (?) dm. high; (root not seen); stem erect, simple below, branched above, loosely leafy, very narrowly winged and striate; leaves sessile, subconnate, broadly elliptic, 2–7 cm. long, .5–2 cm. broad, somewhat abruptly acuminate, 3–5-nerved; inflorescence terminal and axillary 3–6-flowered subumbelliform cymes, pedicels 4 cm. long, usually erect, frequently nodding at apex; calyx-lobes oblanceolate to subspatulate, up to .8 cm. long, .25 cm. wide, 3-nerved, midvein very prominent; corolla 1.0–1.3 cm. long, tube almost one-half the length of the corolla; lobes ovate, erose at apex; spurs small upcurved conical protrusions almost at the orifice of the tube; stamens approximately .5 cm. long, at the orifice of the tube; filaments linear; anthers not seen; capsule ovate, 1.3–1.6 cm. long; seeds oval, brown-black, wrinkled.

Distribution: shrub zone, mountain bases, Colombia.

Specimens examined:

Colombia: Dept. of El Cauca, Mt. Pan de Azucar, alt. 3300–3600 m., June 16, 1922, *Pennell 7034* (ANSP, NY, US); Dept. of Cundinamarca, Sibate, alt. 2700–2800 m., Oct. 13–15, 1917, *Pennell 2438* (M, US); Dept. of Caldas, Cerro Tatama, alt. 3400–3700 m., Sept. 8–10, 1922, *Pennell 10575* (US). (type not seen, *Goudot*, HJP).

Section 2. Haleniastrum

KEY TO NORTH AMERICAN SPECIES AND VARIETIES

1. Spurs spreading to ascending.
   2. Plant less than 2.5 dm. high.
      3. Biennial; flowers white; distribution Mexico.....*20. H. crassiuscula*
      3. Annual; flowers purple; distribution Canada.*23a. H. defleza* var. *Brentoniana*
   2. Plant more than 2.5 dm. high.
      3. Spurs, if present, about ½ the length of the corolla.....*21. H. Pringlei*
      3. Spurs less than ½ the length of the corolla.
         4. Annuals; leaves mostly cauline.
            5. Stem-leaves linear.....*22. H. recurva*
            5. Stem-leaves lanceolate to ovate.....*23. H. defleza*
         4. Perennials; leaves mostly radical.
            5. Strict, many-flowered, spike-like inflorescence.
               6. Stem erect.....*24. H. rhyacophila*
               6. Stem procumbent.....*24a. H. rhyacophila* var. *procumbens*

5. Loose, broad, few-flowered inflorescence.....
.....*24b. H. rhyacophila* var. *macropoda*

1. Spurs pendulous to incurved.
2. Leaves not apiculate or very rarely so; calyx-segments not mucronulate.
3. Basal rosette absent; leaves mostly cauline.
4. Habit erect; leaves less than 3 cm. long.
5. Leaves linear.....*25. H. Palmeri*
5. Leaves lanceolate or ovate.
6. Calyx-lobes mostly obtuse, appressed.....*26. H. Conzattii*
6. Calyx-lobes acute, reflexed.....*27. H. Schiedeana*
4. Habit prostrate; leaves 5–12 cm. long.....*28. H. caleoides*
3. Basal leaves present, cauline few or none.
4. Spurs incurved, ½ or less than ½ the length of the corolla.
5. Sterile branches present; leaves numerous.....*29. H. platyphylla*
5. Sterile branches absent; leaves less than 15.
6. Flowers 1.5 cm. or less long.
7. Flowers less than 1 cm. long; spurs rudimentary..*30. H. nudicaulis*
7. Flowers more than 1 cm. long; spurs ⅓–½ the length of the corolla.....*31. H. plantaginea*
6. Flowers more than 1.5 cm. long...*31a. H. plantaginea* f. *grandiflora*
4. Spurs spreading, about ½ the length of the corolla.
5. Stems always erect.
6. Leaves linear.....*32. H. Shannonii*
6. Leaves elliptical.....*32a. H. Shannonii* f. *compacta*
5. Stems more or less decumbent.....*33. H. decumbens*
2. Leaves conspicuously apiculate; calyx-segments mucronulate.
3. Plant more than 2 dm. high.....*34. H. guatemalensis*
3. Plant less than 2 dm. high.....*34a. H. guatemalensis* var. *latifolia*

20. H. crassiuscula Robinson & Seaton in Proc. Am. Acad. 28: 113. 1893.

Small caespitose biennial of dense habit, slightly fleshy; stems erect, 0.4–1.0 dm. high, narrowly winged, much branched; radical leaves broadly oblanceolate to elliptic, 2 cm. long, obtuse, attenuate into long petiole nearly equalling the blade, 3-nerved; cauline leaves 1–3 pairs, narrowly oblanceolate to oblong, narrowed at the base; inflorescence dense compact umbellate cyme; flowers terminal or axillary, pedicellate, after anthesis slightly nodding, not at all resupinate; calyx-segments lanceolate to oblanceolate, .45–.6 cm. long, obtuse, papillate, 3-nerved; corolla white, up to 1.5 cm. long, about .5 cm. broad at base, tube .35–.4 cm. long; lobes oblong-elliptic, acute; spurs .4 cm. long, arising slightly below the midpoint of the tube, slender, spreading, and curved upwards; stamens .25 cm. long, anthers ovate; filaments linear; capsule lanceolate, frequently subfalcate, acute, 1.4 cm. long; seeds globose, light yellow-brown, granular.

Distribution: bare alpine summits, Mexico.

Specimens examined:

Mexico: Nevado de Toluca, bare alpine summits, alt. 3500 m., Sept. 2, 1892, *Pringle 4229* (ANSP, BG, BM, B, CAS, C, DH, F, G type, IAC, K, M, NY, S, US, V); Ixtaccihuatl, wet meadows, alt. 3000–3250 m., March–July 1903, *Purpus 318* (CAS, M, US); Popocatepetl, Aug. 7–8, 1901, *Rose & Hay 5999* (US).

21. H. Pringlei Robinson & Seaton in Proc. Am. Acad. 28: 113. 1893.

Halenia candida Ramirez in Inform. Secret. Foment. Mexico (Excurs. Mont. Ajusco), 34. 1895; Estud. Hist. Nat. 102. 1904.

Biennial, of glaucous aspect; root thick, tough, ligneous; stem usually solitary, occasionally caespitose, simple or nearly so, scape-like, slender, erect, 1–2.5 dm. high; leaves less than 3 cm. long, radical leaves elliptic to narrowly oblanceolate, faintly 3-nerved, attenuate below into slender petioles, usually as long as the leaf-blade and persistent; cauline leaves 1–2 pairs, sessile, short, sublinear, 1.5–3 cm. long, about .3 cm. broad; flowers disposed in terminal, or occasionally lateral, few-flowered umbelliform cymes, pedicels less than 2 cm. long, usually about .8 cm.; calyx-lobes oblong-spatulate, .3–.5 cm. long, acuminate, 3-nerved; corolla white, .8–1.5 cm. long, spurless in the majority of cases; when spurs present, slender, spreading, and curved-ascending, 1.5–1.8 cm. from tip to tip, with prominent veins and glandular tips; corolla-tube up to .2 cm. long; corolla-lobes elliptic, acuminate; stamens .2–.35 cm. long; anthers narrowly ovate, minutely papillate, filaments linear, slightly uncinate; capsule lanceolate, acute, exserted; seeds subglobose, yellow-brown, granular.

Distribution: springy meadows of central and south Mexico.

Specimens examined:

Mexico: springy alpine meadows, Sierra de las Cruces, alt. 2450 m., Aug. 28, 1904, *Pringle 13121* (BG, C, UC, G, K, US); same locality, Aug. 23, 1892, *Pringle 4209* (ANSP, C, CAS, DH, F, G type, IAC, K, M, NY, S, US, V); same locality, June 1895, *Altamirano 908* (US).

South Mexico: without locality, 1920–21, *Reiche 36* (BG).

The habit of this species is very similar to that of *H. nudicaulis*. The Pringle specimens cited above were collected in August, and the plants are smaller and grow less luxuriantly than the single specimen collected in June by Altamirano. The specimens collected later in the season very rarely possess spurs, while the

earlier plants show a distinctly spurred corolla. This condition is shown in other species to a somewhat less extent, and is in all probability traceable to variation in environmental conditions.

22. H. recurva (Sm.) Allen, n. comb.

Swertia recurva Smith in Rees, Cyclopedia **34**: sub *Swertia*. 1819.

Halenia Rothrockii Gray in Proc. Am. Acad. **11**: 84. 1876; Rothrock, Rept. Wheeler Exped. 195, *pl. 21*. 1878; Hemsl. Biol. Cent.-Am. Bot. **2**: 353. 1882.

Tetragonanthus Rothrockii Heller, Cat. N. Am. Pl. 6. 1898, and ed. 2, 16. 1900.

Annual, 2.5–5 dm. high; stem simple, often branched above; basal leaves less than 3.5 cm. long, .6 cm. broad, elliptic-lanceolate to spatulate; cauline leaves remote, lance-linear, 1.5–4 cm. long, about .35 cm. broad, obscurely 3-nerved, midrib prominent below; inflorescence a loosely flowered subumbellate cyme; flowers on slender pedicels, .5–3 cm. long, often in sevens; calyx lobes lanceolate, elongate-acute, up to .6 cm. long, uninerviate, papillate; corolla bright-yellow, about 1–1.2 cm. long, tube less than one-half the length of the entire corolla; corolla-lobes ovate, subacuminate, delicately veined, papillate; spurs curved, horizontal or ascending, up to 1.6 cm. from tip to tip; anthers broadly oblong, mucronate, papillate; filaments slightly obovate; capsule ovate-lanceolate; seeds yellow-brown, subglobose-ovoid, granular.

Distribution: southern United States and Mexico.

Specimens examined:

UNITED STATES:

ARIZONA: Mt. Graham, alt. 2250 m., Sept. 1874, *Rothrock 733* (ANSP, F, IAC, M, US); same locality, Aug. 1874, *Rothrock* (G, NY); Chiricahua Mts., Sept. 22. 1931, *Jones 28603* (M); Barfoot Park, Chiricahua Mts., alt. 2000–2050 m., rolling andesitic, recently lumbered pine land, Sept. 8, 1906, *Blumer 1359* (BG, D, G, K, M, NY, US, V); same locality, alt. 2480 m., Sept. 22–23, 1914, *Eggleston 10774* (US); Apache Pass, Chiricahua Mts., Sept. 1881, *Lemmon & Lemmon* (CAS); Hermitage, Chiricahua Mts., Sept. 1881, *Lemmon & Lemmon* (CAS); Rucker Valley, Chiricahua Mts., Sept. 1881, *collector unknown 1874* (CAS, DH, F, SM); White Mts., Aug. 1873, *Lour* (F); summit of White Mts. (Springerville-Fort Apache Road), Apache Reservation, alt. 2270–2880 m., Aug. 29, 1919, *Eggleston 15781* (F); Riverside Ranger Station, Greer, Apache Forest, alt. 2700 m., Aug. 24, 1920, *Eggleston 17137* (NY, US); grassy flats near Brinkley's Ranch, White Mts., Aug. 5, 1915, *Ellis 20* (US); Riggs Flat, Pinaleno Mts., alt. 2000 m., Sept. 23, 1917, *Shreve 5373* (G); Columbia Trail, Pinaleno Mts., alt. 2500 m., Sept. 13, 1914, *Shreve 4312* (CAS, US).

NEW MEXICO: Mogollon Mts., on or near the west fork of the Gila River, Socorro Co., alt. 2125 m., Aug. 14, 1903, *Metcalfe 501* (M, NY); swampy ground, divide of Mogollon Mts., Sept. 7, 1881, *Rusby 264* (ANSP, BM, CAS, F, K, M, NY, US); same locality, Aug. 1881, *Rusby* (IAC, NY).

MEXICO:

CHIHUAHUA: Mt. Mohinora, Sept. 1, 1898, *Nelson 4868* (G, US); cool slopes, Sierra Madre, alt. 1750–2375 m., Sept. 27, 1888, *Pringle 1663* (BG, BM, B, CAS, DH, M, NY, S, V); same locality, Sept. 24, 1887, *Pringle 1329* (ANSP, BG, C, G, K, NY, US); Meadow Valley, Sierra Madre Mts., alt. 1750 m., Sept. 17, 1903, *Jones* (S); Sierra Madres, near Colonia Garcia, alt. 2000 m., Sept. 6, 1899, *Townsend & Barber 309* (BB, F, DH, G, M, NY, US); Escalon, *Mutis* (L).

COAHUILA: Sierra Madre, 40 m. south of Saltillo, July 1880, *Palmer 839* (ANSP, G, K, US).

DURANGO: Barranca, below Sandia Station, alt. 1625 m., Oct. 13, 1905, *Pringle 13588* (G, S, UC, US); Sierra de Candela, alt. 3000 m., Aug. 27, 1903, *Endlich 53* (BG).

JALISCO: Sierra de Tequila, alt. 2000 m., July 5, 1893, *Pringle 5465* (G).

The name *Swertia recurva* Smith was given to the specimen collected by Mutis and sent to Linnaeus, now preserved in the herbarium of the Linnaean Society of London. The description published in Rees' 'Cyclopedia' was inadequate, and later the specific name *recurva* was placed under *deflexa*, the well-known northern species. Since few of the succeeding monographers ever saw the original *Swertia recurva* Sm., it is not strange that the error persisted. Over fifty years later, Gray described *Halenia Rothrockii* as a new species. A careful examination of both specimens reveals the fact that they are identical, in which event the correct specific name is *recurva*.

23. H. deflexa (Sm.) Griseb. Gen. & Sp. Gent. 324. 1839; Hook. Fl. Bor.-Am. **2**: 67. *pl. 155*. 1840; Dietrich, Syn. Pl. 2: 918. 1840; Torr. Nat. Hist. N. Y. 2^2: 110. 1843; Robinson in Gray, Man. ed. 7, 659. 1908; Johnson, Tax. Fl. Pl. 488. *fig. 340*. 1931; Louis-Marie, Fl. Man. Prov. Queb. 214, *pl. 68, fig. 11*. 1931.

Swertia deflexa Smith in Rees, Cycl. **34**: sub *Swertia*. 1819.

S. corniculata Michx. Fl. Bor.-Am. **1**: 97. 1803.

S. americana Spreng. Syst. **1**: 661. 1825.

S. Michauxiana G. Don, Gen. Hist. **4**: 177. 1838; Schl. & Cham. in Linnaea **5**: 122. 1830.

Halenia Michauxiana G. Don, Gen. Hist. **4**: 177. 1838.

H. heterantha Griseb. Gen. & Sp. Gent. 325. 1839.

H. reflexa Griseb. in DC. Prodr. **9**: 135. 1845, sphalm.

Tetragonanthus deflexus Kuntze, Rev. Gen. Pl. **2**: 431. 1891; Heller, Cat. N. Am. Pl. 6. 1898, and ed. 2, 161. 1900; Britt. Man. 734. 1901; Britt. & Brown, Ill. Fl. **3**: 15, *fig. 3365*. 1913; Small, Fl. Southeastern U. S. 931. 1913.

T. heteranthus Heller, Muhlenbergia **1**: 2. 1900.

T. heterantherus Heller, Cat. N. Am. Pl. ed. 2, 161. 1900, sphalm.

T. deflexus heteranthus Britt. Man. 735. 1901.

Annual, 1–9 dm. high; stem simple or branched above, quadrangular; leaves 3–5-nerved, basal oblong-spatulate, 1–2 cm. long, petiolate; cauline leaves oblong-lanceolate to ovate, acuminate, 1–5 cm. long, .5–2 cm. broad; internodes 6–8 cm. long; flowers disposed in a terminal or axillary, loose umbelliform verticillate cyme; calyx .4–.8 cm. long, segments ovate-lanceolate, acuminate, papillate; corolla purple, .8–1.4 cm. long, lobes lanceolate to ovate, acute, papillate, tube about equalling the limb; spurs .3–.5 cm. long, slender, cylindrical, obtuse, curved-spreading, deflexed at apex, glandular, frequently lacking in lower flowers or in flowers blooming late in the season; stamens slightly uncinate; anthers ovate, filaments linear; capsule lanceolate; seeds oblong-ovoid, greenish-brown, granular.

Distribution: cool damp woods, from Labrador to New York, west to British Columbia and Montana; also in central Mexico.

Specimens examined:

(?) Labrador: Caribou Island, 1870, *Macfarlane* (BB); same locality, *Martin* (G); without locality, *Rothrock* (F).

Newfoundland: calcareous rocks and talus, entrance to Port Saunders Harbor, Ingornachoix Bay, Aug. 1, 1910, *Fernald, Wiegand & Kittredge 3911* (G); Chimney Cove, Aug. 16, 1896, *Waghorne* (DH, G, M); without locality, *Banks* (G); *Brenton* (K).

Nova Scotia: hills between northeast Margaree and Grand Etang, Cape Breton, Aug. 13, 1906, *Robinson 384* (NY).

New Brunswick: Fredericton, Aug. 1881, *Bailey* (US); Drury's Cove, St. Johns, Aug. 18, 1873, *Boott* (G); Falls, Aroostook River, Aug. 17, 1901, *Churchill* (M); Charlo, Restigouche, July 30, 1894, *Fowler* (US); Sugar Loaf, Restigouche, Bass River, Aug. 3, 4, 1873, *Fowler* (M); same locality and collector, Aug. 1, 1882 (F); St. Johns, July 12, 1877, *Fowler* (ANSP); Eel River, York Co., July 20, 1882, *Hay* (ANSP); open woods, Connors, July 20, 1908, *Mackenzie 3618* (M, NY, US); dry fields, Rothesay, St. Johns, *Mathew* (BG); Saint Francis Parish, July 29, 1900, *Williams* (CAS, G).

Quebec: St. Anne des Monts, Gaspé Co., Aug. 16, 1881, *Allen* (NY); wet woods, Rivière du Loup, *Canby* (F); woods, Lake Memphremagog, July 22, 1902, *Churchill* (G); wet woods about Georgeville, Lake Memphremagog, Aug. 1, 2, 20, 1914,

Churchill (F, G, K, M, NY, US); Carleton, Bonaventure Co., July 23, 24, 27, 1904, *Collins, Fernald & Pease 4261* (G); cool wooded banks, between Baldé and the Baie des Chaleurs, Bonaventure River, Bonaventure Co., Aug. 5, 6, 8, 1904, *Collins, Fernald & Pease* (G); Rivière du Loup, Aug. 1902, *Eggleston 3051* (DH, K, M, NY, S, US); St. Anne des Monts, July 15, 1923, *Eames* (SM); slaty soil, Rimouski, July 18, 1907, *Fernald 1151* (G); alluvial wooded banks, Rivière Ste. Anne des Monts, Gaspé Co., July 16, 1906, *Fernald & Collins 244* (K, NY, UC, US); wood-road along Rivière Cap Chat, Matane Co., Aug. 18, 1923, *Fernald, Dodge & Smith 25986* (G); Matane, near the St. Lawrence, Gaspé, Aug. 6, 1904, *Forbes* (G); Little Metis, Aug. 7, 1906, *Fowler* (G); Anticosti, Aug. 1, 1861, *Hyatt, Shaler & Verrill* (G); Rivière du Loup, Aug. 15, 1892, *Kennedy* (ANSP, G); Mt. Albert, Gaspé, Aug. 1882, *Macoun* (NY); wet rocks, Salt Lake, Anticosti, Aug. 11, 1883, *Macoun* (BM); Anse à Persil, Rivière du Loup, July 1913, *Marie-Victorin 28* (G, NY, SM, US); Baie Girard (Lake Temiscaming), Abitibi, June 27, 1918, *Marie-Victorin 8349* (US); "Lac Sale: dans la prairie naturelle près de la maison du garde," Anticosti, July 23, 1927, *Marie-Victorin & Rolland-Germain 27159* (G); "Rivière Vaureal: talus calcaires," Anticosti, July 31, 1925, *Marie-Victorin, Rolland-Germain & Louis-Marie 21076* (G); "Le long de la Rivière Sainte Anne des Monts; á 10 milles de l'embouchure, Gaspésie," Aug. 3, 1923, *Marie-Victorin, Brunel, Rolland-Germain & Rousseau 17663* (G); Notre Dame de Lac, Temiscouata Co., July 9, 1903, *Moore 1211* (G); same locality, July 30, 1887, *Northrup 69* (NY); Georgeville, July 28, 1902, *Pease 1081* (G); abundant along shores of Lake Memphremagog, Georgeville, July 31, 1902, *Pease 1082* (G); Notre Dame du Lac, Temiscouata Co., July 9, 1903, *Pease 2384* (G); Georgeville, July 31, 1902, *Pease 2910* (G); Rivière du Loup, St. Lawrence, 1860, *Pickering* (G); Lower St. Lawrence, Aug. 6, 1879, *Pringle* (US); shore of St. Lawrence, Temiscouata, Aug. 7, 1879, *Pringle* (F, G, IAC, M, US); banks of Grand River, Gaspé Co., June 20–July 10, 1903, *Richards* (G); "Cap à l'original: clairière; dans un bois de conifères, Comté de Rimouski, Bic," July 19, 1927, *Rousseau 30711* (G, M); "Cap aux Corbeaux: dans un bois de conifères; sur le conglomérat. Bic, Comté de Rimouski," July 14, 1927, *Rousseau 26646* (M); "Ile Bayfield (Sandy Island), Archipel de St. Augustin," Labrador Peninsula, Saguenay Co., July 21, 1915, *St. John 90688* (G); roadside, Lac du Saumon, Matane Co., Aug. 15, 1923, *Svensen & Fassett 2096* (G, SM); Anticosti, *Verrill* (F); damp grassy open meadow, Pointe Nouvelle, Hope Township, Bonaventure Co., July 30, 1902, *Williams & Fernald* (G); Bic, July 16, 1910, *Williamson 1422* (ANSP, NY).

Ontario: banks of the Maitland River, 1836 *Goderiels* (DH); Moose Factory, Hudson's Bay, July 1, 1881, *Haydon* (K); same locality, 1880, *Haydon* (K); between Moose Factory and Rupert's House, southern end of Hudson's Bay, June 12, 1860, *Drexter* (G); Sand River, Aug. 24, 1928, *Heinburger* (COP); Pic River, Lake Superior, *Loring* (G); Lake Huron, Aug. 3, 1871, *Macoun 2239* (DH); Whitefish Island, Lake Huron, Aug. 28, 1901, *Macoun 300* (NY); "Lake Region and Ontario," July 29, 1874, *Macoun 1191* (K); damp woods, Lake Niphigon, July 10, 1884, *Macoun* (BM); Salt, July 29, 1891, *Morton* (D); damp soil, Gray (mile 229 of Algoma Central Ry.), June 23, 1921, *Pease 18030* (G); shaded bank, Burnt Rock Pool, Agawa R., June 21, 1921, *Pease 18058* (G); moss-grown fissures of Laurentian rocks along Onaman River, Thunder Bay District, 1912, *Pulling* (G); Minaki, July 25, 1915, *Thompson 31* (M); swamp, New Hanbury, Aug. 14, 1899, *Umbach* (BG, US); vicinity of Fort William, dry banks, Aug. 5, 1912, *Williamson 2090* (ANSP); same locality, July 15, 1869, *Macoun* (K).

MAINE: Penobscot River, 1836, *Bailey* (NY); Katahdin, woods near Mountain, *Blake* (C, F); swamp woods, *Chute* (F); gravelly thicket, Boundary Lake, St. Francis River Valley, Aroostook Co., Aug. 12, 1902, *Eggleston & Fernald* (G); Brookline (Naskeag Point), *Faxon* (G); open woods, Fort Kent, Aug. 4, 1907, *Fellows* (US); moist banks, Aroostook Co., Aug. 25, 1893, *Fernald* (DH); wooded gravelly river-bank, Island Falls, valley of Mattawamkeag, Aroostook Co., Sept. 6, 1897, *Fernald* (G); wooded river-bank, Van Buren, Aroostook Co., Sept. 18, 1900, *Fernald* (G); damp, wooded slope, Hampden, Penobscot Co., Sept. 8, 1916, *Fernald & Long 14392* (ANSP); argillaceous ledges, Old Town, July 27, 1916, *Fernald & Long 14390* (ANSP, F, SM, US); damp, gravelly woods, Houlton, Aroostook Co., Aug. 26, 1897, *Fernald* (G); low woods, Orono, July 29, 1890, *Fernald* (ANSP, NY); moist banks, along St. Johns River, St. Francis, Aug. 25, 1893, *Fernald 87* (ANSP, C, CAS, G, K, NY, M, US); Bangor, *Hallowell* (BB, IAC); in woods on banks of Penobscot, Oldtowne, 1828, *Oakes* (G); banks of the Wassataquoik River, 1847, *Porter* (M); Seven Islands, Township 13, Ranges 14–15, river-bank, July 25, 1917, *St. John & Nichols 2449* (NY, US); banks of Wassataquoik, Aug. 1847, *Thurber* (F, G, NY); roadside ledge, Frenchville, Aug. 12, 1901, *Williams* (G); Ashland, Fort Kent Road, "Winterville," Aug. 9, 1901, *Williams* (G); on Allagash River, at "Eliza Hole," Aroostook Co., July 28, 1900 *Williams* (G); in loam, borders of spruce woods, Portage Lake, Aug. 9, 1901, *Williams, Robinson & Fernald 58* (ANSP, BG, B, CAS, D, DH, F, G, IAC, K, M, NY, SM, UC, US); banks of the Wassataquoik, common on the Penobscot and its tributaries, Aug. 1847, *Young* (G, NY, UC).

NEW HAMPSHIRE: open pastures, Lombard Hill, Colebrook, Coos Co., July 20, 1917, *Fernald & Pease 16624* (G).

VERMONT: Charlotte, July 28, 1881, *Hosford* (US); same locality and collector, Aug. 3, 1879 (C, F, G, IAC, M); same locality and collector, Aug. 13, 1878 (COP, G); sandy woods, Salem Lake, Derby, Sept. 3, 1931, *Pinkerton & Allen* (M); maple woods, West Woodstock, July 30, 1928, *Kittredge* (M).

MASSACHUSETTS: banks of Manhan River, Southampton, 1830, *Chapman* (M, NY).

NEW YORK: Trenton Falls, Aug. 9, 1883, *Haberer* (CAS, US); same locality, Aug. 18, 1902, *Haberer 601* (G, SM); Fairfield, Herkimer Co., *Hadley* (SM); without locality or date, *Hadley 1* (NY); Sylvan Beach, July 20, 1914, *House 5643* (SM); banks of the Hudson River, North Creek, Warren Co., Sept. 29, 1927, *House 15688* (G, SM); Cocheton, Aug. 1, 1887, *Poggenburg* (NY); Trenton Falls, Aug. 18, 1902, *Peck* (SM); Trenton Falls, Aug. 29, 1868, *Schaffer* (ANSP); Cocheton, July 1887, *Schrenk* (NY, SM).

MICHIGAN: St. Helena Island in northern Lake Michigan, July 19, 1886, *Arnold* (BB); Mackinac, July 17, 1881, *Boyce* (IAC); without locality, Aug. 28, 1892, *Dodge 352* (?) (M); near Port Huron, Aug. 16, 1892, *Dodge* (BB, F, G, US); same locality, Aug. 16, 1895, *Dodge* (US); Keweenaw Co., July 4, 1888, *Farwell 249* (UC); low grounds, Keweenaw Co., Aug. 1890, *Farwell 770* (G); Big Stone Bay, Emmet Co., piney-aspen woods, July 31, 1925, *Gates 14156* (S); weeds in trail in *Thuja* bog, Reese's, Douglas Lake, Cheboygan Co., June–Aug. 1917, *Gates & Gates 10716* (F, M); same locality, Aug. 12, 1916, *Gates & Gates 9768* (BB); Cedar Swamp, Boyne Falls, July 27, 1878, *Hill 179* (F); Isle Royale, July 21, 1889, *Holway* (IAC, NY); Cedar Swamp, Cheboygan, Aug. 20, 1890, *Kofoid* (G, M); moist soil in wet places, Grayling, July 28, 30, 1903, *Mell & Knopf* (M); Mackinac Island, July 28, 29, 1898, *Millspaugh 82* (F); Lake Superior, *Parry* (NY); Mackinac Island, 1888, *Puckner* (CAS); on Isle Royale and south shore of Lake Superior, Keweenah Point, 1862, *Robbins 102*

(G, M); Keweenah Point, 1863, *Robbins 95* (MU); without locality, Aug. 1887, *Root* (F); Chandler's Falls of the Escanaba River, Aug. 27, 1892, *Wheeler* (US); Thunder Bay Island, July 18, 1895, *Wheeler* (US); same locality and collector, Aug. 12, 1895 (NY); Harbor Springs, Aug. 10, 1890, *Wheeler* (F); Isle Royale, woods, mainland, Aug. 15–16, 1912, *Williamson 2218* (ANSP).

WISCONSIN: Pike River Falls, sandy pine woods, Aug. 18, 1884, *Hasse* (ANSP, NY); Menominee River banks, July 1892, *Schuette* (F); Lake Superior, Aug. 23, 1893, *Harper* (M); Minah R., Door Co., July 27, 28, 29, 31, 1887, *Schuette* (F, G, K, NY, US); Europe Lake, Ellison Bay, Door Co., July 18, 1918, *Stanton 19* (M); Cato Rapids, 1874, *Swezey 17* (US).

ILLINOIS: Grand Detour, *Porter* (BB); same locality, Aug. 5, 1865, *Smith* (ANSP); same locality, Aug. 5, 1866, *Smith 5026* (BB).

MINNESOTA: pine woods, Lake Itaska, July 1891, *Aiton* (BB, NY, US); Benedict, Norway-Jack pine forest, July 10, 1914, *Bergman 2948* (NY); dry pine lands, Itaska Co., Aug. 1891, *Burglehaus* (M); Duluth, July 11, 1877, *Hall* (BB); Grand Marais, shore of the Bay and Lighthouse Point, Lake Superior, Aug. 9, 1920, *Rydberg 9619* (NY); Lake Itaska, pine woods, July 1891, *Sandberg* (CAS, F); Two Harbors, July 1, 1891, *Sandberg 457* (US); Grand Rapids, Aug. 6, 1891, *Sandberg 719* (US); woods and shores, Lake Co., shady woods, Itaska Lake, *Sandberg 1151* (F, US); Duluth, 1887, *Vasey* (US); north shore, Lake Superior, 1890, *Wheeler & Jones 1054* (G); Fond du Lac, July 19, 1889, *Woods* (US).

SOUTH DAKOTA: slate schist, under willows, North Rapid Ranger Station, alt. 1400 m., Black Hills National Forest, July 12, 1908, *Murdock 3072* (F, G, NY); woods south of Box Elder Creek, Lawrence Co., Aug. 3, 1924, *Over 16145* (US); Custer, alt. 1375 m., Aug. 15, 1892, *Rydberg 878* (NY, US); Nashy, Black Hills, July 25, 1912, *Visher 1557* (NY).

SASKATCHEWAN: 1857–8, Palliser's Brit. N. Am. Exped., *Bourgeau* (BG, G); Cumberland House Fort, *Drummond* (G, K).

MONTANA: Columbia Falls, *Mrs. J. J. Kennedy 38* (NY); same locality, July 17, 1892, *Williams 903* (C, NY, US).

ALBERTA: Rocky Mt. House, forest floor, open, Nordegg Distr., Sept. 24, 1928, *Brinkman 3678* (NY).

BRITISH COLUMBIA: Kicking Horse Valley, near Field, alt. 1000 m., July 21, 1906, *Brown 667* (ANSP, G, NY, US); Field, July 14, 1904, *Farr* (K); same locality, Aug. 18, 1909, *Olson* (G); between Field and Emerald Lake, Aug. 20, 1904, *Macoun 68734* (?) (NY); Ottertail, July 13, 1904, *Williamson* (ANSP).

CANADA WITHOUT LOCALITY: 1838, *Franklin & Douglas* (DH); "foret près de Fort Ellice" (rare), Aug. 26, 1857, *Bourgeau* (K); "Terra Hudsonica," 1837, *Grisebach* (BG); June 1849, *Leston* (DH); *MacNab* (K); 1869, *Macoun 77* (US); *Percival* (ANSP).

MEXICO: Très Marias Mts., alt. 2375 m., Morelos, Dec. 16, 1907, *Pringle 13971* (US); Rincón, alt. 2300 m., Morelia, April 1909, *Arsène 37* (US).

The Rothrock specimen listed from Labrador is from an early collection made before the Canadian boundaries were permanently established. No definite locality is given, and it is probable that Labrador is incorrect and that the plant actually came from a point further south. This is the case of the specimen collected

by Macfarlane and that by Martin as well, both, according to the label, from Caribou Island, Labrador. Caribou Island is now included in Nova Scotia. For this reason, it is doubtful if the area of distribution of the species proper extends as far north as Labrador.

23a. H. deflexa var. **Brentoniana** Gray, Syn. Fl. N. Am. ed. 2, 2^1: 127. 1886.

Halenia Brentoniana Griseb. Gen. & Sp. Gent. 325. 1839; Dietrich, Syn. Pl. **2**: 918. 1840; Hook. Fl. Bor.-Am. **2**: 67. *pl. 156*. 1840.

Tetragonanthus deflexus var. *Brentonianus* Britt. in Mem. Torr. Bot. Club **5**: 261. 1894; Britt. & Brown, Ill. Fl. **3**: 15. 1913.

T. Brentonianus Heller, Cat. N. Am. Pl. 6. 1898; Muhlenbergia **1**: 2. 1900.

Low plant, 0.3–1.5 dm. high; stem erect, much branched, nodes more approximate than in the species; leaves 3–5-nerved, the radical leaves similar to species, upper subsessile, oblong-lanceolate; inflorescence a 3-flowered cyme with the center flowers on long pedicels; corolla purple, .8–1.0 cm. long, tube .3–.5 cm. long; corolla-lobes ovate, acuminate, delicately veined, papillate; spurs broad or slender and subhorizontal; calyx .5–.7 cm. long, segments elliptical, acuminate, 3-veined, papillate; stamens approximately .2 cm. long; anthers broadly ovate; filaments linear.

Distribution: Labrador, southward to Nova Scotia and Quebec.

Specimens examined:

LABRADOR: Red Bay, Sept. 7, 1891, *Bowdoin College 290* (G); on the gneiss plain, in sand, Blanc Sablon, Str. Belle Isle, July 30, 1910, *Fernald & Wiegand 3909* (G, K, NY); damp sand, Forteau, Belle Isle, July 30, 1910, *Fernald, Wiegand & Kittredge 3910* (G); 1842, *Loring* (G); Battle Harbor, July 5, 1926, *Sewall & Weed* (F); Aug. 10, 1895, *Stearns* (US); hills, Forteau, Aug. 8, 1893, *Waghorne* (G, M, US); Battle Harbor, Aug. 6, 1913, *Williamson 559* (ANSP, NY); same locality, *Williamson 547* (ANSP, NY); on dry sandy hillside, under 100 m., Cartwright, Sandwich Bay, July 31, 1926, *Woodworth 357* (G).

NEWFOUNDLAND: "lieux humides où secs et découverts à près du Pain de Suève, St. Pièrre," Aug. 19, 1901, *Louis-Arsène 365* (NY); "lieux humides où secs, découverts où boisés, mais plus généralement sans les bois où sous les buissons, St. Pièrre, Pain de Suève," Aug. 26, 1901, *Louis-Arsène 403* (G); 1776, *Banks* (BM); without locality or date, *Brenton 144a?* (K); Bay St. George, dry sandy field along shore, Aug. 12, 1908, *Eames & Godfrey 3030* (ANSP, G, K); turfy slopes of slaty hills, Little Quirpon, Quirpon Harbor, Aug. 6, 1925, *Fernald & Long 28950* (G, UC); boggy limestone barrens, Capstan Point, Flower Cove, Str. Belle Isle, July 28, 1924, *Fernald, Long*

& Dunbar 26982 (G); turfy limestone shore, sandy cove, Ingornachoix Bay, Aug. 9, 1924, *Fernald, Long & Dunbar 26983* (G, K); dry peaty barren, near Biscay Bay, Avalon Peninsula, Aug. 16, 1924, *Fernald, Long & Dunbar 26984* (G); by rills on seepy silicious slope of Joan Hill, Bay Bulls, Avalon Peninsula, Aug. 21, 1924, *Fernald, Long & Dunbar 26985* (G); in turf on granite ledges, Gaultois southern coast, Aug. 29, 1924, *Fernald, Long & Dunbar 26986* (G); peaty and gravelly open slopes, French or Tweed Island, Bay of Islands, Sept. 2, 1926, *Fernald, Long & Fogg 381* (G); wet moss and peat on gneiss hills near sand bank west of Burges, Distr. of Burges and LaPoile, Sept. 9, 1926, *Fernald, Long & Fogg 382* (G); grassy fields overlying conglomerate limestones and calcareous sandstones, Cowhead, Silurian coastal region north of St. Paul's Bay, July 22, 1910, *Fernald & Wiegand 3908* (G, US); wet mossy, turfy slopes of sandstone and arenaceous slate hills back of Carbonear, shores of Conception Bay, Avalon Peninsula, Aug. 6, 7, 1911, *Fernald & Wiegand 6081* (ANSP, BG, G, K, NY, UC); damp sandy shores, St. Georges, Aug. 13, 1910, *Fernald, Wiegand & Kittredge 3912* (G); springy swale and turfy upper border of strand, Anse aux Sauvages, Pistolet Bay, Aug. 11, 1925, *Fernald, Wiegand & Long 28951* (G); wet soil, top of exposed cliff, Belle Isle, Sept. 16, 1901, *Howe* (F); same locality, *Howe & Lang 1298, 1408* (G, NY); Port à Port, hillside on Cape St. George, 2 miles west, July 29, 1921, *Mackenzie & Griscom 10411* (G); Green Gardens, Cape St. George, July 25, 1922, *Mackenzie & Griscom 11135* (G); without locality, *Morison* (K); barrens, Flower Cove, Aug. 10, 1920, *Priest* (G); rocky hills, St. Johns, Aug. 1–19, 1894, *Robinson & Schrenk 180* (ANSP, BG, C, DH, G, K, NY, M, US); Barren Islands, Aug. 20, 1903, *Sornborger* (G, NY, US); Salmonier, Aug. 1885, *Thaxter* (G); dry turf, roadside, Old Perlican, Trinity Bay, Aug. 5, 1914, *Torrey 35* (G); Harbor Grace, Aug. 6, 1911, *Williamson 501* (ANSP); same locality, July 1, 1911, *Williamson 601* (NY).

Nova Scotia: damp soil of sea bluffs, Torbay, Aug. 22, 1901, *Howe* (F); exposed grassy seabluff, Money Point, Cape North, Cape Breton Island, Sept. 3, 1916, *Nichols 1901* (G); Grand Etang, Cape Breton, on exposed headland, Aug. 14, 1906, *Robinson 410* (NY).

Quebec: "sur les hauteurs des coteaux: Ile du Havre-aux-Maisons. Iles de la Madeleine," Aug. 14, 1919, *Marie-Victorin & Rolland-Germain 9647* (F, G); "Cap-aux-Meules, Ile de l'Etang-du-Nord. Iles de la Madeleine," Aug. 11, 1919, *Marie-Victorin & Rolland-Germain 9881* (G); "Natashquan: Ile à Charles, à l'entrée du Havre; sur le gneiss laurentien, Gulf St. Laurent," July 20, 1924, *Marie-Victorin & Rolland-Germain 18482* (ANSP, G); "Ile Kécarponi, Archipel de Kécarpoui, turfy shore, Labrador Peninsula, Saguenay Co.," Aug. 11, 1915, *St. John 90687* (G); Natashquan River, Saguenay Co., July 24–Aug. 10, 1912, *Townsend* (G).

Canada without Locality: 1828, *Despaux* (DH).

24. H. rhyacophila[52] Allen, n. sp.

Perennial with one to several erect floriferous stems, 2.5–6 dm. high, somewhat branched, slightly winged, internodes extremely

[52] **H. rhyacophila** Allen, sp. nov.—Perennis, caulibus 1–multis, erectis, floriferis, 2.5–6 dm. altis, aliquid ramosis, parvulum alatis; internodiis inferioribus, brevissimis (.5–2 cm.); ramis brevibus sterilibus foliosis radice saepe ascendentibus; foliis basalibus saepe in rosula densa, lanceolatis usque ellipticis, acutis, in petiolis longis attenuatis, 3–5-nerviis, medio-nervo prominenti, marginibus plus minusve undulatis,

short (.5–2 cm.) on lower portion of stem; short sterile leafy branches frequently arising from the root-stalk; basal leaves often in a dense rosette, lanceolate to elliptic, about 7 cm. long, acute, attenuate into long petioles, 3–5-nerved, with prominent midvein, margins more or less undulate; cauline leaves linear to linear-lanceolate, sessile or subsessile, acute, 1.5–3.5 cm. long; inflorescence pedunculate, terminal or axillary, loose, open, racemose, cymose, frequently of spike-like appearance; calyx .55–.9 cm. long, one-half to nearly three-fourths the length of the corolla; lobes 3-nerved, lanceolate, more or less attenuately acute, papillate; corolla .7–1.5 cm. long, .5–.8 cm. broad, tube one-third or less the length of the entire corolla; corolla-lobes oval to ovate or obovate, acute to acuminate, margin crisped, usually papillate; spurs one-fourth to one-third the length of the entire corolla, slightly ascending; stamens .3–.5 cm. long; anthers oblong to oval; filaments linear; capsule broadly lanceolate, up to 1.5 cm. long; seeds elliptical, granular, brownish.

Distribution: known only from Costa Rica.

Specimens examined:

Costa Rica: Potrero del Alto, Volcan Poas, alt. 2461 m., Aug. 31, 1890, *Pittier 2975* (US); same locality, Aug. 1896, *Tonduz 10865* (US); *Pittier & Tonduz 10805* (B); "région supérieure du Cerro de Buena Vista," alt. 3000 m., Jan. 1891, *Pittier 3499* (B); "près du sommet del'Irazu," alt. 3000 m., July 10, 1891, *Tonduz 4316* (B); "près du sommet de les pelouses," Dec. 12, 1888, *Pittier 744* (B); Volcan Irazu, Dec. 31, 1910, *Cristan* (US); same locality, alt. 2275 m., 1923, *Lankester 670* (US); same locality, Aug. 4–5, 1920, *Rowlee & Stork 899* (NY, US); same locality, alt. 2250 m., March 1894, *Smith 4888* (F, G, US); same locality, alt. 2500 m., June 25, 1874, *Kuntze 2356* (K, NY); same locality, 1845–8, *Oersted 10772* (UC); in monte Reventado, alt. 2250 m., 1845–8, *Oersted 10773* (UC); *Warscewicz 216* (BG).

Pittier 2975 and *Oersted 10772, 10773* are not typical, since it is evident that the main axis has been broken, resulting in the

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ca. 7 cm. longis; foliis caulinis linearibus vel lineari-lanceolatis, sessilibus subsessilibusve, acutis, 1.5–3.5 cm. longis; inflorescentia terminali axillarive, laxa, pedunculata, racemosa, cymosa, saepe spicata; calyce .55–.9 cm. longo, ½ usque ad ca. ¾ corollae longitudini adaequanti; lobis trinerviis, lanceolatis, plus minusve attenuate acutis, papillatis; corolla .7–1.5 cm. longa, .5–.8 cm. lata, tubo ⅓ vel minus totae corollae longitudini adaequanti; corollae lobis ovalibus usque ovatis vel obovatis, acutis usque acuminatis, plerumque papillatis, margine crispo; calcaribus ¼ usque ad ⅓ corollae longitudini adaequantibus, parvulum ascendentibus; staminibus .3–.5 cm. longis; antheris oblongis vel ovalibus; filamentis linearibus; capsula late lanceolata, usque ad 1.5 cm. longa; seminibus ellipticis, fulvis, granosis.—Costa Rica: Potrero del Alto, Volcan du Poas, alt. 2461 m., Aug. 31, 1890, *Pittier 2975* (US TYPE).

formation of short stunted floral branches. Specimens collected by Friedrichstahl, now preserved at Kew and Geneva, are also possibly abnormal plants of *H. rhyacophila*.

24a. H. rhyacophila var. **procumbens**[53] Allen, n. var.

Stems 1–several, decumbent, the central larger, bearing most of the flowers; basal leaves few; foliose branches with very short internodes, sterile or bearing few flowers at tip; inflorescence erect, more or less strict and spike-like, many-flowered, similar to that of species; corolla greenish-white.

Distribution: Costa Rica.

Specimens examined:

Costa Rica: wet thickets on the southern slopes of Volcan de Turrialba, near the Finca del Volcan de Turrialba, alt. 2000–2400 m., Feb. 22, 1924, *Standley 35285* (US type).

The generally procumbent appearance of this specimen may be due to the fact that it was found growing in wet thickets.

24b. H. rhyacophila var. **macropoda**[54] Allen, n. var.

Stems 1–several, slightly branching, nodes remote; sterile branches frequently short, leafy, with short internodes; basal leaves few, lanceolate-elliptic, extremely acuminate, with long narrow petioles, 3-nerved; upper leaves broadly lanceolate, acuminate; inflorescence a loose racemose cyme; flowers usually borne on very long slender pedicels, more or less pendulous; corolla greenish-white; seeds oblong-ovoid, granular, wrinkled, yellow-brown. In other respects similar to species.

[53] **H. rhyacophila var. procumbens** Allen, var. nov.—Caulibus 1–compluribus, decumbentibus, centrali majori paucos flores gerenti foliis basalibus paucis; ramis foliosis, internodiis brevissimis, sterilibus vel summo paucos flores gerentibus; inflorescentia simile speciei, erecta, plus minusve stricta, spicata, multo-florifera; corolla viridi-candida.—Costa Rica: wet thickets on the southern slopes of Volcan de Turrialba, near the Finca del Volcan de Turrialba, alt. 2000–2400 m., Feb. 22, 1924, *Standley 35285* (US type).

[54] **H. rhyacophila var. macropoda** Allen, var. nov.—Caulibus 1–compluribus, parvulum ramosis, nodiis remotis; ramis saepe brevibus, foliosis, sterilibus, internodiis brevibus; foliis basalibus paucis, lanceolato-ellipticis, acuminatissimis, petiolis longis, angustis, 3-nerviis; foliis superioribus late lanceolatis, acuminatis; inflorescentia laxa, racemoso-cymosa; floribus plerumque pedicellis longissimis tenuibus, plus minusve pendentibus; corolla viridi-candida; seminibus oblongo-ovatis, granosis, rugosis, flavo-fulvis.—Costa Rica: Volcan Poas, alt. 2678 m., Jan. 30, 1922, *Greenman & Greenman 5994* (M type).

Distribution: Costa Rica.

Specimens examined:

COSTA RICA: common in wet forests on the southern slope of Volcan de Turrialba, near the Finca del Volcan de Turrialba, alt. 2000–2400 m., Feb. 22, 1924, *Standley 35141* (US); upper regions of the Volcan de Turrialba, alt. 2500–3400 m., Jan. 1, 1899, *Pittier 13076* (US); Volcan Poas, alt. 2678 m., Jan. 30, 1922, *Greenman & Greenman 5994* (M TYPE); lava fields, Irazu, 1854–55, *Hoffmann 119* (BG).

The last specimen cited from Mount Poas is more rigid than those from Turrialba, and the inflorescence is more open, but there is no doubt that it is the variety.

25. H. Palmeri Gray in Proc. Am. Acad. **21**: 401. 1886.

Tetragonanthus Palmeri Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Plant about 3–5 dm. high; stems simple or branched, striate; cauline leaves linear, sessile, faintly 3-nerved; lower leaves lanceolate, faintly 3-nerved, obtuse; inflorescence thyrsoid, many-flowered; calyx-segments .4–1.2 cm. long, lanceolate, acute, 3-nerved, midrib prominent, margin papillate; corolla 1–2.2 cm. long, yellow, tube .7–1.0 cm. long; corolla-lobes broadly ovate, acute, slightly auriculate, papillate; spurs tapering, incurved, ¼ the length of the entire corolla; anthers oblong; filaments linear, slightly uncinate; capsule about 15 cm. long, lanceolate, attenuate, subfalcate; seeds globose, dark brown, granular.

Distribution: mountains of northern and central Mexico.

Specimens examined:

MEXICO:

CHIHUAHUA: sixty miles south of Guadalupe y Calvo, Sierra Madres, alt. 1875–2125 m., Aug. 1898, *Nelson 4798* (K, US); Sierra Madres, near Colonia Garcia, alt. 1875 m., Sept. 4, 1899, *Townsend & Barber 303* (BG, BM, DH, F, G, M, NY, US); Marsh Lake, alt. 1750 m., Sept. 19, 1903, *Jones* (BM, D, M, US); without locality, Aug.–Nov. 1885, *Palmer 359* (ANSP, BM, G, IAC, K, NY, US).

DURANGO: without locality and date, *Garcia 410* (US).

26. H. Conzattii Greenm. in Publ. Field Mus. Bot. **2**: 335. 1912; Briq. in Candollea **4**: 318. 1931.

Erect branching herb, 2.5–3.7 dm. high; stem terete or angular, rather coarse; leaves sessile, lanceolate, ovate, subacute, 1–4 cm. long, 0.5–1 cm. broad, 3-nerved; basal leaves ovate-elliptic with petioles nearly equalling the blade; inflorescence terminal or seemingly axillary, but actually terminal on short branches less than 1 cm. long, pedicels up to nearly 2 cm. long; calyx-segments spatulate, 3-nerved, papillate; corolla .8–1.2 cm. long, .4–.65 cm.

broad, green or yellow-green; lobes .3–.5 cm. long, ovate, acute, papillate; spurs slender, incurved, .2 cm. long; stamens .2–.5 cm. long; anthers broadly ovate; filaments linear; capsule 1.1–1.8 cm. long, lanceolate, subfalcate; seeds globose-ovoid, yellow-brown, granular.

Distribution: State of Oaxaca, Mexico.

Specimens examined:

OAXACA: Sierra de San Felipe, alt. 2500 m., Sept. 15, 1894, *Pringle 4908* (ANSP, BG, CAS, D, DH, G, IAC, K, M, NY, US, V); Cerro San Felipe, alt. 2375–2750 m., 1894, *Nelson 1115* (G, US); same locality and date, *Nelson 1164* (US); same locality, alt. 2000 m., Sept. 20, 1908, *Conzatti 2295* (F); same locality, alt. 2500 m., Sept. 1, 1894, *Smith 236* (M); 18 miles southwest of the city of Oaxaca, alt. 1875–2375 m., Sept. 10–20, 1894, *Nelson 1340* (US); cerro Grande de Huanclilla, distrito de Nochistlan, alt. 2520 m., Oct. 13, 1921, *Conzatti 4265* (US); Cumbre de Ixtepec, 1842, *Liebmann 10771* (UC); Mont Tanga, 2000 m., 184–, *Galeotti 1489* (B).

MEXICO, WITHOUT LOCALITY: *Jurgensen 812* (DH, K).

27. H. Schiedeana (Schl. & Cham.) Griseb. Gen. & Sp. Gent. 327. 1839; DC. Prodr. **9**: 130. 1845; Hemsl. Biol. Cent.-Am. Bot. **2**: 353. 1882.

Swertia Michauxiana Schl. & Cham. in Linnaea **5**: 122. 1830, excl. syn.

Tetragonanthus Schiedeanus Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Halenia chlorantha Greenm. in Proc. Am. Acad. **41**: 240. 1905.

Annual, 2–6.5 dm. high; stems erect, simple below, frequently branched above, narrowly winged; basal leaves ovate, 2 cm. long, 1.5 cm. broad, length of petioles equalling that of blade, gradually decreasing toward the summit; cauline leaves petiolate, ovate to broadly lanceolate, 3–6 cm. long, 1.5–2 cm. broad, 3–5-nerved, acute; inflorescence terminating the stem and branches in several-flowered cymose clusters; pedicels erect, 1.5 cm. or less in length; calyx-segments lanceolate-elliptic, conspicuously papillate, approximately .5 cm. long, 3-nerved, lateral veins near the margin, usually strongly reflexed; corolla .8–1.1 cm. long, greenish; tube nearly equalling the obovate abruptly acuminate papillate lobes; spurs .2–.3 cm. long, tapering, tips glandular, nearly parallel with the tube, slightly incurved; stamens .2 cm. long; filaments linear; capsule oblong, subfalcate, 1.2 cm. long; seeds globose, yellow-brown, granular.

Distribution: wet woods of Central Mexico.

Specimens examined:

MEXICO: Serro de Colorado, Aug. 1828–9, *Schiede & Deppe 248* (BG TYPE).

HIDALGO: wet woods near Trinidad Iron Works, alt. 1425 m., July 11, 1904, *Pringle 8939* (ANSP, BG, BM, C TYPE of *H. chlorantha*, CAS, DH, K, M, NY, S, UC, US, V).

VERA CRUZ: Chiconguiaco, Sierra Madre, Aug. 1912, *Purpus 6011* (CAS).

28. H. caleoides[55] Allen, n. sp.

Perennial with thick leafy angled, more or less decumbent stem, bearing short leafy branches at central nodes and more elongate floral branches above; leaves conspicuously decurrent on stem; lower cauline leaves about 12 cm. long, lanceolate-elliptic, acute, 3-nerved; midvein prominent, attenuate into broad petiole about 2.5 cm. long; upper cauline leaves subsessile or very slightly petiolate, lanceolate, acute, 3-nerved; inflorescence a subumbellate axillary or terminal cyme; flowers on angled, rather pendulous peduncles, less than 2 cm. long; calyx about equalling the corolla; segments lanceolate, acuminate, reticulately veined at tip, papillate; corolla about 1.2 cm. long, greenish, tube about equalling the lobes; lobes broadly triangular, apiculate, papillate, margin crisped; spurs pendulous, shorter than the corolla; anthers ovate-oblong, filaments linear; capsule immature.

Distribution: Guatemala.

Specimens examined:

GUATEMALA: vicinity of Agua, alt. 2700–3000 m., March 22, 1905, *Maxon & Hay 3675* (US TYPE); "wasservulcan bei Santa Maria," alt. 3000–4000 m., *Scherzer* (V).

29. H. platyphylla[56] Allen, n. sp.

[55] **H. caleoides** Allen, sp. nov.—Perennis, caule crasso, folioso, angulato, plus minusve decumbenti, centralibus nodiis ramos breves foliosos, et supra ramos elongatiores floriferos gerenti; foliis conspicue decurrentibus; foliis inferioribus caulinis ca. 12 cm. longis, lanceolato-ellipticis, acutis, 3-nerviis, medio-nervo prominente, in petiolis latis attenuatis, ca. 2.5 cm. longis; foliis superioribus caulinis subsessilibus vel parvulum petiolatis, lanceolatis, acutis, 3-nerviis; inflorescentia cymosa, subumbellata, axillari terminalive; floribus in pedunculis angulatis, aliquam pendentibus, minusquam 2 cm. longis; calyce corollae subaequanti, segmentibus lanceolatis, acuminatis, summo reticulato-nerviis, papillatis; corolla ca. 1.2 cm. longa, viride; tubo lobis subaequanti; lobis late triangularibus, apiculatis, papillatis, margine crispo; calcaribus pendulis, corolla brevioribus; antheris ovato-oblongis, filamentis linearibus; capsula immatura.—GUATEMALA: vicinity of Agua, alt. 2700–3000 m., March 22, 1905, *Maxon & Hay 3675* (US TYPE).

[56] **H. platyphylla** Allen, sp. nov.—Perennis erectus, ca. 3.5 dm. altus, 1–2 caulibus floriferis globo denso foliorum basalium in verticillis in caulibus brevibus caespitosis

Erect perennial, about 3.5 dm. high; 1–2 flowering stems, arising from a dense bushy rosette of basal leaves borne in whorls on short caespitose sterile stems springing from a heavy ligneous root; stems narrowly winged, more or less erect; basal leaves elliptic to lanceolate, petioles persistent, longer than blade, acuminate, prominently 3-nerved; 1–several pairs of cauline leaves, the upper subtending 1–2 flowers, with increasingly shorter petioles the more remote the nodes from the base; inflorescence usually a terminal subumbellate cyme, with pedicels of varying length up to 2 cm.; calyx foliaceous, oblanceolate-ovate, acuminate, two-thirds to three-fourths the length of the corolla, margin crisped, 3-nerved, reticulate at tip, papillate; corolla 1.3 cm. long, tube about one-half the length of the entire corolla; lobes ovate, margins more or less crisped, acute; slender spurs, about one-third the length of the corolla, tips incurved and pendulous; filaments linear; capsule lanceolate; seeds immature.

Distribution: known only from the type locality.

Specimens examined:

Guatemala: Volcan de Agua, Dept. Zacatepequez, alt. 2875 m., April 1890, *Smith 2170* (G type, US).

30. H. nudicaulis Mart. & Gal. in Bull. Acad. Brux. 11[1]: 371. 1844; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

Halenia Purpusi Brandegee, Zoe **5**: 235. 1906.

Halenia scapiformis Briq. in Candollea **4**: 322. 1931.

Perennial, 1.4–3 dm. high, often branched from or near the base; root ligneous; stem angled; radical leaves elliptic to lanceolate, 2–10 cm. long, attenuate into a long persistent petiole,

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sterilibus gestorum ascendentibus, ex radice crasso ligneo aptis; caulibus anguste alatis, plus minusve erectis; foliis basalibus ellipticis usque lanceolatis, petiolis persistentibus, longioribus quam lamina, acuminatis, prominente trinerviis, 1-pluribus geminis foliorum caulinorum, superioribus 1–2 flores subtendentibus, petiolis deinceps brevioribus remotioribus a basi nodiis; inflorescentia plerumque terminali, subumbellata, cymosa, pedicellis usque 2 cm. longis; calyce folioso, oblanceolato-ovato, acuminato, ⅗ usque ¾ corollae longitudini adaequanti, margine crispo, ad apicem 3-nerviis, reticulatis, papillatis; corolla 1.3 cm. longa, tubo ½ totae corollae longitudini adaequanti; lobis ovatis, marginibus plus minusve crispis, acutis; calcaribus tenuibus, acuminis incurvatis pendentibusque, circa ⅓ corollae longitudini adaequantibus; filamentis linearibus; capsula lanceolata; seminibus immaturis.—Guatemala: Volcan de Agua, Dept. Zacatepequez, alt. 2875 m., April 1890, *J. D. Smith 2170* (G type, US).

3-nerved, midvein prominent; cauline leaves linear to broadly elliptic, 1–2 pairs, more or less reduced; inflorescence cymose, 4–6 terminal or axillary flowers on pedicels .2–1.5 cm. long; calyx-segments oblong, .2–.5 cm. long, 3-nerved, acute to abruptly acuminate; corolla .7–1 cm. long, white, tube .25–.4 cm. long, with minute protuberances or reduced, apparently glandular, incurved spurs about midway up the tube; corolla-lobes ovate-oblong, often mucronate; stamens approximately .2 cm. long, uncinate; stigmatic surfaces reflexed; capsule lanceolate, exserted, slightly curved; seeds globose, brown, granular.

Distribution: subalpine meadows of southern Mexico.

Specimens examined:

VERA CRUZ: Mt. Orizaba, alt. 2500 m., July 1841, *Liebmann 10778* (BG, UC); same locality, alt. 2500–2750 m., Aug. 1840, *Galeotti 7220* (B TYPE, DH, V).

PUEBLA: Chinanthe, alt. 1750–2000 m., May 1841, *Liebmann 10776* (BG, UC); same locality, 1841–3, *Liebmann* (NY).

MEXICO: Ixtaccihuatl, Oct. 1905, *Purpus 1760* (BG, CAS, F, G, M, US); Popocatepetl, Sept. 1908, *Purpus 3070* (BG, BM, CAS, DH, F, G, M, NY, US); Lecima, Sierra de Ajusco, Aug. 18, 1896, *Harshberger 137* pp. (ANSP).

OAXACA: Mont Tanga, alt. 2000–2250 m., July 1840, *Galeotti 1488* (B, DH); near Reyes, alt. 1875–2600 m., Oct. 17, 1894, *Nelson 1748* (US); vicinity of Cerro San Felipe, alt. 2375–2750 m., 1894, *Nelson 1096* (G, US); northwest summit of Mt. Zempoaltepec, alt. 2500–2750 m., July 5–13, 1894, *Nelson 652* (US); same locality, alt. 2850 m., *Nelson 636* pp. (US).

SOUTH MEXICO: without locality: *Liebmann 10774* (UC); *Ehrenberg 608* (BG); Sierra San Pedro Nolasco, 1843–4, *Jurgensen 811* (DH, K).

31. H. plantaginea (HBK.) Griseb. Gen. & Sp. Gent. 327. 1839; Dietrich, Syn. Pl. **2**: 918. 1840; Griseb. in DC. Prodr. **9**: 130. 1845; Wedd. Chlor. And. **2**: 75. 1859; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882; Conzatti, Fl. Syn. Mex. 174. 1897.

Swertia plantaginea HBK. Nov. Gen. & Sp. Pl. **3**: 175. 1818; Kunth, Syn. Pl. **2**: 266. 1823.

Halenia elongata D. Don ex G. Don, Gen. Hist. **4**: 177. 1838.

H. nutans Mart. & Gal. in Bull. Acad. Brux. **11**[1]: 371. 1844.

Tetragonanthus plantagineus Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Perennial, 1.5–3.5 dm. high; stems 1–many, narrowly winged, erect, simple below, frequently bearing short floriferous branches above; basal leaves numerous, in a rosette, lanceolate, elliptic to ovate, 3-nerved, 2–5 cm. long, .5–1 cm. broad, obtuse to acute,

or apiculate, petioles persistent; cauline leaves 1–2 pairs, sessile, linear to lanceolate, 2–3 cm. long, the upper usually subtending floriferous branches; inflorescence a terminal or axillary cyme, individual floral clusters of varying density, pedicels slender, slightly curved, .5–2.2 cm. long; calyx-segments lanceolate-elliptic, acute to abruptly acuminate, papillate, one-third to one-half the length of the corolla, 3-nerved; corolla yellow, campanulate, extremely narrowed at the base, 1–1.5 cm. long, tube not quite equalling the lobes; lobes ovate, obtuse to acute; spurs extremely slender, appressed, incurved at tip, one-third to one-half the length of the entire corolla; filaments linear; anthers ovate; capsule elliptical, subfalcate, 1.5–1.8 cm. long, .5 cm. broad; seeds subglobose, brown, granular.

Distribution: mountains of Mexico.

Specimens examined:

VERA CRUZ: pine forests, Citlaltepetl, alt. 2750–3000 m., Sept. 1907, *Purpus 2766* (BG, BM, CAS, F, G, M, NY, US); Mt. Orizaba, alt. 3250 m., Sept. 1841, *Liebmann 10780* (UC); same locality, July 25–26, 1901, *Rose & Hay 5730* (US); same locality, Sept. 28, 1828, *Schiede & Deppe 246* (BG, BM, M, V); same locality, Aug. 6, 1891, *Seaton 205* (C, G, NY, US); same locality, *Galeotti 7222* (B TYPE of *H. nutans*, V).

OAXACA: "in summo monte San Felipe," July, April 1834, *Andrieux 226* (DH, G, K, V).

HIDALGO: Sierra de Pachuca, July 21–22, 1901, *Rose & Hay 5569* (US); same locality, alt. 2500 m., Aug. 22, 1902, *Pringle 11033* (BG, F, G, K, M, NY, US); between Pachuca and Real del Monte, Aug. 31, 1903, *Rose & Painter 6665* (G, US); Real del Monte, *Coulter 939* (BM, G, K, NY).

MEXICO: Monte de Rio Frio, road from Mexico City to Pueblo, alt. 4000 m., July 31, 1929, *Mexia 2693* (US, M).

MICHOACAN: "In monte Jorullo," alt. 3000 m., *Humboldt & Bonpland* (BG TYPE of *Swertia plantaginea*).

SOUTH MEXICO, WITHOUT LOCALITY: *D. Don* (K TYPE of *H. elongata*); coll. of 1845, *Woelfflin* (NY); *Wawra 424, 952* (V); coll. of 1830, *Karwinsky 122* (V).

31a. H. plantaginea f. grandiflora[57] Allen, n. forma.

Similar to species, but a larger more sturdy plant with heavier root system, frequently more than 6 stems, usually branched

[57] **H. plantaginea f. grandiflora** Allen, forma nov.—Similis speciei, sed herba major, robustior, radice crassiori, caulibus saepe plusquam sex, plerumque supra ramosis; foliis basalibus multis, petiolis longis, tenuibus, persistentibus, plerumque lanceolatis, 3–5-nerviis, obtusis acutisve; inflorescentia multo-florifera plerumque densiori majorive quam speciei; corolla 1.2–2.5 cm. longa, latiora et dilatatiora summo quam speciei; calcaribus totae corollae ca. ⅓ longitudini adaequantibus; calyce ca. ½ vel minus corollae longitudini adaequanti.—MEXICO: Nevado de Toluca, Sept. 2, 1892, *Pringle 4224* (ANSP, BG, BM, B, C, CAS, G, M TYPE, NY, K, S, US).

above; numerous basal leaves for the most part lanceolate, 3–5-nerved, obtuse or acute, petioles long, slender, persistent; inflorescence many-flowered, usually more dense than the species; flowers larger; corolla 1.2–2.5 cm. long, broader than in the species and more expanded at the tip; spurs approximately one-third the length of the entire corolla; calyx approximately one-half or less than one-half the length of the corolla.

Distribution: mountains of Mexico.

Specimens examined:

MEXICO:

MEXICO: near Salazar, Sept. 14, 1903, *Rose & Painter 7025* (US); Nevado de Toluca, Oct. 16, 1903, *Rose & Painter 7964* (NY, US); same locality, Oct. 15, 1903, *Rose & Painter 7910* (US); same locality, Sept. 2, 1892, *Pringle 4224* (ANSP, BG, BM, B, C, CAS, DH, G, M TYPE, NY, K, S, US, V); same locality, *Heller 391* (V); Cerro de San Miguel, Nov. 1912, *Salazar* (US); Sierra de las Cruces, Sept. 14, 1903, *Pringle* (UC); near Orizaba, alt. 2500–3000 m., Aug. 1838, *Linden 935* (K).

OAXACA: Sierra de San Felipe, alt. 2500 m., June 23, 1894, *Pringle 4720* (ANSP, BG, B, BM, CAS, DH, G, IAC, K, M, NY, S, UC, US, V).

MORELIA: Loma La Huerta, Nov. 1911, *Arsène* (DH, US).

MICHOACAN: Angangueo, 1837, *Hartweg 347* (BG, BM, DH, NY).

The form *grandiflora* appears to be only a variation, due merely to habitat, moisture, or some nutritional factor. It has no distinctive geographical distribution. It may be noted that the specimens cited from Hidalgo under the species are all alike in having slightly more round basal leaves, though aside from this character, they could not be distinguished from the type specimen of *plantaginea*.

32. H. Shannonii Briq. in Candollea **4**: 321. 1931.

Erect plant, less than 2 dm. high; stems mostly simple, angled, frequently more than one arising from the base; leaves somewhat fleshy with sunken veins; basal leaves narrowly oblanceolate, petiolate, acute, 3.5–7 cm. long, .3–.6 cm. broad, 3-nerved; cauline leaves 2–3 pairs, oblanceolate to lanceolate, acute, sessile, 3-nerved; inflorescence axillary or terminal, several-flowered subumbellate cymes, pedicels .7–2.5 cm. long, curved at tip, angled; calyx foliaceous, one-half to two-thirds the length of the corolla; calyx-segments oblong-elliptic, .6–.9 cm. long, abruptly acuminate, reticulate, 3-nerved, papillate; corolla nearly 1.5 cm. long, tube almost one-half the length of the entire corolla; lobes ovate, obtuse to acutish, margins irregularly crenulate, papillate; spurs

divaricate, slightly incurved, pointed; anthers ovate, filaments linear; capsule immature.

Distribution: volcanic regions of Guatemala.

Specimens examined:

Guatemala: Volcan de Agua, Dept. Zacatepequez, alt. 2000 m., June 1892, *Shannon 3630* (US); same locality, alt. 3100 m., Aug. 1892, *Shannon 3613* (G, DH type, M, K, US); same locality, alt. 3400–3752 m., March 22, 1905, *Pittier 39* (US); Volcan de Fuego, 1861, *Salvin & Godman 311, 249* (K); same locality, alt. 3000 m., Nov. 17, 1873, *Salvin* (K).

32a. H. Shannonii f. **compacta**[58] Allen, n. forma.

Stem shorter than in species; leaves broader than in species, elliptic, acuminate; inflorescence similar to species but less open, more clustered; flowers on shorter pedicels.

Distribution: known only from type locality.

Specimens examined:

Guatemala: mountains above Chiantla, Huehuetenango, May 29, 1906, *Cook 45* (US type).

33. H. decumbens Benth. Pl. Hartw. 67. 1840; Griseb. in DC. Prodr. **9**: 130. 1845; Hemsl. Biol. Cent.-Am. Bot. **2**: 351. 1882, excl. syn.

Halenia longicornu Mart. & Gal. in Bull. Acad. Brux. **11**[1]: 370. 1844; Hemsl. Biol. Cent.-Am. Bot. **2**: 352. 1882.

H. apiculata Mart. & Gal. Bull. Acad. Brux. **11**[1]: 371. 1844.

Tetragonanthus decumbens Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

T. longicornis Kuntze, Rev. Gen. Pl. **2**: 431. 1891.

Perennial, 1.5–3.5 dm. high; stems more or less decumbent, frequently short sterile branches arising from the root with a dozen or more leaves clustered at the tip; fertile branches ascending, simple, striate, angled; basal leaves with long petioles, almost equalling the blade, elliptical to broadly elliptical-oval, 3 cm. or less in length, .6–1.2 cm. broad, midrib prominent, faintly 3-nerved, subacute; 1–5 pairs of cauline leaves, with petioles increasingly shorter toward the tip, the upper sessile, subconnate, elliptical to lanceolate, 1–2.5 cm. long, .4–.8 cm. broad, very faintly 3-nerved, acute, midrib prominent; inflores-

[58] **H. Shannonii** f. **compacta** Allen, forma nov.—Caule breviori quam speciei; foliis latioribus, ellipticis, acuminatis; inflorescentia simili speciei sed densiore, confertiora; floribus in brevioribus pedicellis.—Guatemala: Chiantla, Huehuetenango, May 29, 1906, *Cook 45* (US type).

cence terminal or axillary in upper pair of leaves, forming a several-flowered cymose cluster; upper pedicels erect, 2 cm. or less long, the lower frequently pendulous, usually shorter, 4-angled; calyx-segments oblong to elliptic, acute or abruptly acuminate, 3-nerved, papillate, over one-half the length of the corolla excluding the spurs; corolla 1–1.5 cm. long, lobes elliptic-oval, delicately veined, papillate, margin slightly crisped or apiculate; corolla-tube slightly more than one-half the length of the entire corolla; spurs .5–.7 cm. long, .2 cm. broad at the base, tapering at the tip, spreading, descending and incurved; stamens about .2 cm. long; anthers ovate, filaments linear; capsule .8–1 cm. long, .3–.5 cm. broad, broadly elliptical; seeds subglobose, depressed, brownish, granular.

Distribution: mountains of Mexico.

Specimens examined:

MEXICO:

OAXACA: "in monte Pelado, dictionis Oaxacacae," 1841, *Hartweg 494* (BM, DH, K TYPE, NY, V); from Monte Pelado and on Tanetze, east-northeast from Oaxaca, July, 1845, *Jurgensen 386* (DH, K); "cordillera, Cerra San Felipe, hautes montes," alt. 2000–2375 m., April–Sept. 1840, *Galeotti 7166* (B TYPE of *H. longicornu*, DH TYPE of *H. apiculata*, K, M fragment, V); northwest slope of Mt. Zempoaltepec, alt. 2000–2500 m., July 10, 1894, *Nelson 698* (US); same locality, June 1842, *Liebmann 10770* (UC); summit of Mt. Zempoaltepec, alt. 2800 m., July 9, 1894, *Nelson 636* pp. (US).

34. H. guatemalensis Loesener in Verh. Bot. Ver. Brandenb. **55**: 182. 1913.

Perennial, 2.5–4 dm. high; stem subterete, internodes 7–12 cm. long; leaves prominently decurrent; basal leaves oblanceolate, attenuate into long narrow petioles, 3–6 cm. long, 1–1.5 cm. broad, acute or abruptly acuminate; lower cauline leaves petiolate, 3-nerved, obtuse or subrotund at apex, abruptly apiculate; upper cauline leaves sessile or subsessile, 2–3 pairs, elliptic-ovate to lanceolate; inflorescence terminal, subumbellate, 2–7 flowers, the lower hardly shorter than the cauline leaves, a single or two flowers inserted below the umbel in the axils of the higher leaves; pedicels striate, tetrangular, 3 cm. or less long; calyx about two-thirds the length of the corolla, segments obovate-spatulate, mucronulate, 3-nerved, reticulate; corolla yellow-green, about 2 cm. long; lobes ovate or oval, subacute at apex, many-nerved; spurs one-half the length of the entire corolla, narrow, slightly

spreading, descending and curved inward at the tip; stamens approximately .2 cm. long; anthers subovoid; capsule subrostriform, about 1.8 cm. long, .5–.6 cm. broad; seeds globose, depressed, granular.

Distribution: Guatemala.

Specimens examined:

GUATEMALA: Huehuetenango, Todos los Santos, road near Chiantla, alt. 3000 m., Sept. 11, 1896, *Seler & Seler 2728* (BG TYPE); Nebaj, Dept. Quiché, alt. 2300 m., April 1890, *Heyde & Lux 4729* (BM, G, K, US); mountains near Hacienda of Chaucol, alt. 2750, Jan. 2, 1896, *Nelson 3646a* (US).

34a. H. guatemalensis var. **latifolia** (Loesener) Allen, n. comb.

Halenia plantaginea var. *latifolia* Loesener in Verh. Bot. Ver. Brandenb. **55**: 182. 1913.

Habit similar to that of the species, but smaller and more rigid.

Distribution: Guatemala.

Specimens examined:

GUATEMALA: "Huehuetenango, Bergwald oberh. Todos los Santos," alt. 2800–3000 m., June 19, 1896, *Seler & Seler 3086* (BG TYPE).

KEY TO SOUTH AMERICAN SPECIES AND VARIETIES

1. Spurs usually pendulous and incurved.
  2. Spurs reduced to small protuberances, less than ¼ the length of corolla.
    3. Flowers .5–.6 cm. long.
      4. Flowers single, apical, or disposed in 1–3-flowered cymes..... ..... *35. H. valerianoides*
      4. Flowers more numerous (usually 5), subumbellate..... *36. H. pusilla*
    3. Flowers about 1 cm. or more long.
      4. Calyx-segments spatulate..... *37. H. spatulata*
      4. Calyx-segments usually oblong-lanceolate..... *38. H. caespitosa*
  2. Spurs conspicuous, ¼–½ the length of corolla.
    3. Stems sterile, densely leafy; leaves fleshy or coriaceous.
      4. Leaves lanceolate or oblong-lanceolate..... *39. H. hypericoides*
      4. Leaves obovate..... *40. H. pulchella*
      4. Leaves linear..... *41. H. pinifolia*
    3. Sterile stems none; leaves thin, herbaceous.
      4. Stem single; rosette absent..... *42. H. gracilis*
      4. Stems 1–many; rosette present in complete plant.
        5. Flowers 1–1.5 cm. long; plant yellow-green..... *43. H. Killipii*
        5. Flowers less than 1 cm. long (except in *H. Weberbaueri*); plant not yellow-green.
          6. Flowering stem scapiform, almost aphyllous; flowers 5 or less. ..... *44. H. Mathewsii*
          6. Flowering stem leafy; flowers more than 5.
            7. Leaves linear, narrowly linear-lanceolate.
              8. Plant less than 20 cm. high.

9. Plant more than 10 cm. high; flowers .6–.7 cm. long... ....*45. H. vincetoxicoides*
9. Plant less than 10 cm. high; flowers 1.2–1.5 cm. long.... ....*46. H. Weberbaueri*
8. Plant more than 25 cm. high....*47 H. Stuebelii*
7. Leaves ovate-lanceolate to oblong-lanceolate; stem stout, rigid....*48. H. robusta*

2. Spurs conspicuous, ½–¾ the length of the corolla.
3. Stem decumbent, suffruticose; leaves subcoriaceous....*49. H. taruga gasso*
3. Stem usually erect, not suffruticose.
4. Flower 2–3 cm. long....*50. H. gigantea*
4. Flower less than 1.5 cm. long.
5. Leaves less than .8 cm. long....*51. H. minima*
5. Leaves more than .8 cm. long.
6. Flowering stems curved at apex....*52. H. penduliflora*
6. Flowering stems erect.
7. Pedicels scarcely 1 cm. long; flowers in dense heads.
8. Cauline leaves oblong, hardly narrowed at base.... ....*53. H. phyteumoides*
8. Cauline leaves lanceolate or oblong-lanceolate, gradually elongated into petiole, dilated at base....*54. H. Herzogii*
7. Pedicels more than 1 cm. long; flowers more loosely clustered.
8. Flowers less than 1 cm. long....*55. H. silenoides*
8. Flowers more than 1 cm. long.
9. Spurs slender, more or less parallel; plant more than 15 cm. high....*56. H. umbellata*
9. Spurs thick, distinctly incurved at tip; plant usually less than 15 cm. high....*57. H. Meyeri Johannis*

1. Spurs pendulous, divaricate.
2. Spurs scarcely ¼ the length of the corolla, more or less divergent at tip.
3. Stems and branches densely and long-ciliate....*58. H. barbicaulis*
3. Stems and branches not ciliate, smooth.
4. Pedicels of apical flowers more than 1.5 cm. long.
5. Leaves ovate to obovate-lanceolate....*59. H. Rusbyi*
5. Leaves linear or linear-lanceolate.
6. Plant more than 10 cm. high, not caespitose....*60. H. Purdieana*
6. Plant less than 10 cm. high, densely caespitose.... ....*60a. H. Purdieana* var. *congesta*
4. Pedicels of apical flowers less than 1.5 cm. long....*61. H. Hieronymi*
2. Spurs ½–¾ the length of the corolla, horizontally or subhorizontally divaricate, but incurved at apex.
3. Stem strict; sterile branches none; basal leaves rigid and erect, disposed in a dense rosette....*62. H. bifida*
3. Stems more or less flexuous; sterile branches numerous; basal leaves not rigid, occasionally recurved, not disposed in a dense rosette... ....*63. H. Weddelliana*

1. Spurs horizontal or reflexed.
2. Flowers 3–4 cm. long....*64. H. elegans*
2. Flowers less than 2 cm. long.

3. Flowers less than 1 cm. long.....*65. H. Hoppii*
3. Flowers more than 1 cm. long.
4. Sepals ovate-lanceolate.
5. Leaves thin, herbaceous, no rosette; spurs thick.....*66. H. asclepiadea*
5. Leaves subcoriaceous; dense, many-leaved rosette; spurs slender.
.....*67. H. Kalbreyeri*
4. Sepals obovate or oblanceolate.
5. Rosette and lower leaves lanceolate, slightly narrowed at base into a short petiole.....*68. H. bella*
5. Rosette and lower leaves obovate, long-petiolate.....*69. H. sphagnicola*

35. H. valerianoides Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 106. 1916.

Small caespitose perennial, less than .5 dm. high; root very thick and densely branching; stems short, erect, 2–3 cm. high, almost leafless, arising from a dense rosette of basal leaves; basal leaves thick, petiolate, oblanceolate, 2–3 cm. long, .4 cm. broad, acute, obsoletely 3-nerved; cauline leaves broadly sessile, 1 pair or none, ovate-oblong, .5–.6 cm. long, .2–.3 cm. broad; inflorescence a terminal 1–3-flowered cyme, pedicels .7–1.0 cm. long; calyx-lobes obovate-oblong, .3 cm. long, .2 cm. broad, acute, obsoletely 3-nerved; corolla approximately .5 cm. long, .4 cm. broad, tube slightly less than one-half the length of the entire corolla; lobes ovate, acute; spurs small laterally prominent protuberances at the base of the corolla.

Distribution: Peru and Bolivia.

Specimens examined:

PERU: (TYPE not seen, *Weberbauer 1676*, BG, M photo). According to Gilg, this number is incorrect, since the data given does not agree with the specimen.

BOLIVIA: Chacaltaya, 130 klm. from La Paz, alt. 4800 m., Feb. 1908, *Buchtien 1484* (US); Alaska Mine, alt. about 4500 m., March 1–4, 1926, *Tate 67* (NY).

36. H. pusilla Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 107. 1916.

H. Dombeyana var. *brevicornis* Wedd. Chlor. And. **2:** 76. 1859, fide Gilg, *l. c.*

Perennial caespitose herb, under .5 dm. high; root short, thick, covered with remains of marcescent leaves, bearing at the apex a dense rosette of leaves; flowering stems numerous, densely crowded, erect, short; rosette leaves petiolate, very thick, oblanceolate, 1–1.5 cm. long, .2–.3 cm. broad, acute, obsoletely 3-nerved; cauline leaves 1–2 pairs, closely approximated, sessile,

ovate-oblong to oblong, .6–.7 cm. long, .3–.35 cm. broad; inflorescence a few-flowered (5 usually) cyme, pedicels up to 1 cm. long; calyx-lobes oblong-lanceolate, .5 cm. long, .2 cm. broad, acute, obsoletely 3-nerved; corolla .5–.6 cm. long, tube about one-half the length of the entire corolla; lobes ovate, acute; spurs small laterally prominent protuberances at the base of the corolla; stamens about .2 cm. long; filaments linear; anthers ovate, tip attenuate; capsule ovate.

Distribution: Bolivia and Peru.

Specimens examined:

BOLIVIA: Prov. Larecaja, on road to Lacatia, in meadows, in vicinity of Sorata, alt. 3200–3700 m., *Mandon 369* pp. (V).

PERU: Cerro de Pasco, alt. about 4600 m., March 28, 1923, *MacBride 3072* (F, M); Piñasniocj, Panticalla Pass, alt. 3600 m., June 18, 1915, *Cook & Gilbert 1793* (US).

37. H. spatulata[59] Allen, n. sp.

Perennial caespitose herb, up to .8 dm. high; root coarse, woody; 1–2 flowering stems, erect, simple or rarely branched from base, occasional short sterile leafy branches; numerous basal leaves attenuate into long petioles, elliptic to spatulate, up to 2.5 cm. long, .4–.5 cm. broad, prominently uninerviate; cauline leaves 1–2 pairs, sessile, elliptic, less than 1 cm. long; inflorescence usually terminal, 1–few-flowered cyme, pedicels erect or slightly recurved at tip; calyx-lobes spatulate, up to .6 cm. long, .2 cm. broad, 3-nerved; corolla 1 cm. long, "lime green," tube over one-half the length of the entire corolla; lobes broadly ovate, acute; spurs approximately one-fourth the length of the corolla, pendulous and incurved, broad at the base, attenuate at tip; stamens

[59] **H. spatulata** Allen, sp. nov.—Herba perennis, caespitosa, usque ad .8 dm. alta; radice crassa, lignea; 1–2 caulibus floriferis, erectis, simplicibus vel raro e baso ramosis, vel ramis brevibus sterilibus foliosis; foliis basalibus multis, longis petiolis attenuatis, ellipticis vel spatulatis, usque ad 2.5 cm. longis, .4–.5 cm. latis, prominente 1-nerviis; foliis caulinis 1–2 geminis, sessilibus, ellipticis, minusquam 1 cm. longis; inflorescentia plerumque terminali, cymosa, 1–pauco-florifera; pedicellis erectis vel ad apicem parum recurvatis; calycis lobis spatulatis, usque ad .6 cm. longis, .2 cm. latis, 3-nerviis; corolla 1 cm. longa, "viride"; tubo plusquam ½ corollae longitudini adaequanti; lobis late ovatis, acutis; calcaribus ¼ corollae longitudini subaequanti, pendulis incurvatisque, ad basin latis, ad apicem attenuatis; staminibus ca. .2 cm. longis; filamentis linearibus; antheris ovatis; capsula late lanceolata; stigmatibus truncatis, planis superficiebus, ut videtur, stigmaticibus.—PERU: Dept. Cusco, open, grassy páramo, Cerro de Colquipata, alt. 3900–4000 m., May 1, 1925, *Pennell 13749* (ANSP TYPE, NY, US).

about .2 cm. long; filaments linear, anthers ovate; capsule broadly lanceolate; stigmas truncate, the flat surfaces apparently stigmatic.

Distribution: Peru.

Specimens examined:

PERU: Dept. Cusco, open grassy páramo, Cerro de Colquipata, alt. 3900–4000 m., May 1, 1925, *Pennell 13749* (ANSP TYPE, NY, US).

38. H. caespitosa Gilg in Fedde, Rep. Spec. Nov. **2**: 53. 1906; Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 107. 1916.

Small caespitose herb, forming a broad dense mat .5–.8 dm. in diameter, usually .4–.5 dm. high, the flowering stems frequently reaching a height of 1–1.5 dm.; sterile branches usually intermingled with the fertile; leaves in dense aggregation, very fleshy, petiolate, obovate-lanceolate to oblanceolate, 1.5–2 cm. long, about .3–.4 cm. broad, acute, nerves scarcely conspicuous; cauline leaves, when present, sessile, oblong-lanceolate to linear-lanceolate, 1–2 cm. long; inflorescence usually consisting of a 1-, rarely 2–3-, flowered cyme at the apex of the fertile stem, pedicels 1.6–2 cm. long, erect or slightly nodding; calyx-lobes oblanceolate to oblong-lanceolate, .6–.8 cm. long, .2 cm. broad, acute to obtusish, 3-nerved; corolla about 1 cm. long, greenish, length of tube nearly equalling that of the entire corolla; lobes ovate, subrotund, crisped; spurs pendant, .1–.2 cm. long and almost as thick; stamens approximately .4 cm. long, attached just below the sinus; filaments linear, anthers ovate; capsule linear.

Distribution: moist places in Peru.

Specimens examined:

PERU: Oroya, near Lima, alt. 3300–3600 m., 1919, *Kalenborn 91*[60] (M, US); wet stream margin, Morococha, May 23, 1922, *Macbride & Featherstone 898* (F, M); "Hacienda Arapa bei Yauli, an der Lima-Oroya-Bahn," alt. 4400 m., 1906, *Weberbauer 279* (BG TYPE, DH, M photo).

39. H. hypericoides (HBK.) G. Don, Gen. Hist. **4**: 177. 1838; Griseb. Gen. & Sp. Gent. 328. 1839.

Swertia hypericoides HBK. Nov. Gen. & Sp. Pl. **3**: 176. 1818; Roem. & Schult. Syst. Veg. **6**: 76. 1820.

Perennial herb; stem procumbent, branching, leafy, less than

[60] The specimen in the Herbarium of the Missouri Botanical Garden was collected by *Margaret Kalenborn, No. 91*. That from the United States National Herbarium bears the same number, but the collector is *A. S. Kalenborn*. In all probability these are the same collection.

.3 dm. high; lower leaves several pairs, approximate, petiolate, sheathing at base, oblong-lanceolate or lanceolate, 2 cm. long, acute, 3-nerved; upper leaves smaller, sessile, oblong; inflorescence terminal and axillary many-flowered panicles, pedicels up to 1.5 cm. long; calyx-lobes linear-lanceolate, about .5 cm. long; corolla .7–.8 cm. long, yellowish; lobes ovate, acute; spurs pendulous, incurved, subconical, about one-half the length of the corolla; filaments linear, anthers oblong; capsule oblong, obtuse, compressed; seeds subglobose, blackish brown, smooth.

Distribution: Colombia.

No specimen examined, but description compiled from original publication and photograph. (TYPE, *Humboldt & Bonpland*, HJP, M photo).

40. H. pulchella Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 107. 1916.

Perennial herb, .5–1.0 dm. high; root thick, elongate; axis elongate, more or less procumbent, densely covered with obsolete remains of leaves, the apex curved-erect, sending out a single loosely leafy flowering stem, and some few (3–5) sterile procumbent or curved-erect leafy branches 3–13 cm. long; rosette leaves lacking; lower cauline leaves broadly petiolate, upper sessile, rather fleshy, obovate, 1.2–1.6 cm. long, .5–.6 cm. broad, manifestly 3-nerved, veins sunken above, prominent below, acute; inflorescence composed of terminal and axillary pseudoracemose 3-flowered cymes, more or less approximate, pedicels .6–1.2 cm. long; leaves subtending inflorescence, minute, euphylloid; calyx-lobes oblong-lanceolate to oblanceolate, about .8 cm. long, .25–.3 cm. broad, 3-nerved, margin hirtellous; corolla about 1 cm. long, tube less than one-half the length of the entire corolla; lobes ovate, somewhat acute, auriculate; spurs pendulous, incurved, about one-half the length of the corolla; stamens about .2 cm. long; filaments linear, anthers ovate.

Distribution: Ecuador.

Specimens examined:

ECUADOR: in the Andes, *Jameson 53* (DH TYPE, M photo, V).

Very similar to *H. Weddelliana*, but rather stouter, more leafy, and spurs less divergent.

41. H. pinifolia (R. & P.) G. Don, Gen. Hist. **4**: 177. 1838. *Swertia pinifolia* (R. & P.) ex Don, *l. c.*

Perennial herb, growing in tufts, .7–1.5 cm. high; stems erect, simple; leaves linear, channeled, acute, edges scabrous; inflorescence umbellate; calyx-lobes ovate-lanceolate, acute; corolla golden-yellow; spurs straight, one-half as long as the corolla.

Distribution: cordilleras of the Andes of Peru.

No specimens examined, but description compiled from original publication. (TYPE, *Ruiz & Pavon*—Herbarium at Madrid).

42. H. gracilis (HBK.) G. Don, Gen. Hist. **4**: 177. 1838; Griseb. Gen. & Sp. Gent. 327. 1839; DC. Prodr. **9**: 130. 1845 (excl. var.).

Swertia gracilis HBK. Nov. Gen. & Sp. Pl. **3**: 170. 1818.

Halenia pichinchensis Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 109. 1916.

H. Jamesoni Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 115. 1916.

Annual herb, up to 3 dm. high; stem simple, erect, minutely striate; few basal leaves suggesting a rosette, usually fugacious, with persistent bases, broadly elliptic to ovate, attenuate into narrow petioles longer than the blade, up to 3 cm. long, up to 1 cm. broad, acute, prominently 3-nerved; cauline leaves up to 5 pairs, at intervals of 4 cm., petiolate, elliptic, becoming broadly lanceolate toward the summit of the stem, acute, 3-nerved; floral leaves smaller than cauline; inflorescence few-flowered (2–6) axillary and terminal cymes, erect pedicels up to 1.2 cm. long; calyx-lobes more or less obovate, papillate, approximately .6 cm. long, .2 cm. broad, abruptly acuminate, 3-nerved, reticulate at tip; corolla 1–1.5 cm. long, greenish, tube one-half the length of the entire corolla; lobes ovate, acuminate; spurs slightly less than one-third the length of the corolla, very slender, slightly divergent, the tip frequently, but not always, slightly incurved; stamens approximately .3 cm. long, attached just below the summit of the tube; filaments linear, anthers oval, abruptly acuminate; stigmas broad, recurved; capsule lanceolate, subfalcate, 1.8 cm. long; seeds reticulate.

Distribution: Colombia and Ecuador.

Specimens examined:

COLOMBIA: Zipaquira, alt. 2730 m., *Humboldt & Bonpland* (HJP TYPE, M photo).

ECUADOR: Pichincha, *Karsten* (BG, V); on Mt. Pichincha, opposite Quito, March 3, 1920, *Heilborn 457* (V); La Planta del Chillo, about Tanque, alt. 2700 m., April

2, 1920, *Firmin 697* (US); near Quito, coll. of 1864, *Jameson* (V); about Quito, *Jameson* (ANSP, BG); Guagrapata, *Spruce 5151* (V).

Halenia gracilis shows a marked relationship to *Halenia Schiedeana* of Mexico. The specimens which Gilg has described as *H. Jamesoni* and *H. pichinchensis* appear to be conspecific with *gracilis*. In the opinion of the author, the only possible difference is the texture of the leaves, which in the *Jamesoni* specimen is slightly rougher than that of the *gracilis* type.

43. H. Killipii[61] Allen, n. sp.

Pale green perennial, .3–2.5 dm. high; root coarse, heavy, ligneous, covered with darkened remains of leaves; stem stout, conspicuously alate; basal leaves few, fleshy, in rosette, attenuate into long petioles, oblanceolate, 2–4 cm. long, .3–.35 cm. broad, 3-nerved, obtuse; cauline leaves 1–3 pairs, sessile, linear-lanceolate, 1.5–2.5 cm. long, .3 cm. broad, inconspicuously 3-nerved, obtuse; inflorescence 1 (rarely 7)-flowered, usually terminal, subumbellate cyme, pedicels erect or slightly nodding, up to 2.5 cm. long; calyx-lobes elliptic, .5–.9 cm. long, yellowish-green, acute, obsoletely 3-nerved; corolla 1–1.5 cm. long, tube about one-third the length of the entire corolla; lobes broadly ovate, erose; spurs thick, pendulous, incurved, about one-third the length of the corolla; stamens about .2 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate at apex, yellowish-green.

Distribution: Peru.

Specimens examined:

PERU: Dept. Junín, Mount La Juntay, near Huancayo, alt. 4700 m., April 27, 1929, *Killip & Smith 22087* (US TYPE); same locality and date, *Killip & Smith 22083* (US).

[61] H. Killipii Allen, sp. nov.—Herba perennis, pallida viride, .3–2.5 dm. alta; radice crassa, lignea, reliquiis foliorum tecta; caule robusto, conspicue alato; foliis basalibus paucis, carnosis, in rosula, petiolis longis attenuatis, oblanceolatis, 2–4 cm. longis, .3–.35 cm. latis, 3-nerviis, obtusis; foliis caulinis 1–3 geminis, sessilibus, lineari-lanceolatis, 1.5–2.5 cm. longis, .3 cm. latis, inconspicue 3-nerviis, obtusis; inflorescentia 1 (raro 7)-florifera, plerumque terminali, subumbellata-cymosa; pedicellis erectis vel parum nutantibus, usque ad 2.5 cm. longis; calycis lobis ellipticis, .5–.9 cm. longis, flavo-viridibus, acutis, obsolete 3-nerviis; corolla 1–1.5 cm. longa; tubo ca. ⅓ corollae longitudini adaequanti; lobis late ovatis, erosis; calcaribus crassis, pendulis, incurvatis, ca. ⅓ corollae longitudini adaequanti; staminibus .2 cm. longis; filamentis linearibus, antheris ovatis; capsula ovata, apice attenuati, flavo-viride.—PERU: Dept. Junin, Mt. La Juntay, near Huancayo, alt. 4700 m., April 27, 1929, *Killip & Smith 22087* (US TYPE); same locality and date, *Killip & Smith 22083* (US).

44. H. Mathewsii Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 111. 1916.

H. asclepiadea Griseb. Gen. & Sp. Gent. 326. 1839; in DC. Prodr. **9:** 129. 1845, pp; non *Swertia asclepiadea* HBK. fide Gilg, *l. c.*

Perennial herb, up to 2.5 dm. high (usually less than 1.5 dm.); subterranean axis thick, short, erect; numerous flowering stems erect, slender, sparingly leafy; basal leaves in dense rosette, herbaceous, petiolate, obovate-oblong, up to 2.5 cm. long, .4–.5 cm. broad, the lowest equal and equidistant on the stem, the uppermost sessile and much reduced, oblong or ovate-oblong, more or less acute, obsoletely or inconspicuously 5-nerved; inflorescence a 5-flowered cyme, on a more or less scapiform stem; pedicels of terminal flowers 2 cm. long, of laterals 1.5 cm., decreasing toward the base; calyx-lobes oblanceolate, about .55 cm. long, acute, obsoletely 3-nerved; corolla about .7 cm. long, tube about one-third the length of the entire corolla; lobes ovate-oblong, subrotund; spurs pendulous, slightly incurved, one-third the length of the corolla.

Distribution: Peru.

Specimens examined:

PERU: near Huamatanga, *Mathews 523* (V TYPE); Dept. Lima, swale on páramo, near Antaicocha, Cerro Colorado, east of Canta, alt. 4000–4200 m., June 20, 1925, *Pennell 14878* (ANSP, NY, S, US); Dept. Lima, open hillside, Rio Blanco, alt. 3000–3500 m., April 15–17, 1929, *Killip & Smith 21757* (US).

45. H. vincetoxicoides Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 108. 1916.

Tetragonanthus Whitei Rusby in Mem. N. Y. Bot. Gard. **7:** 321. 1927.

Perennial herb, 1.5–2 dm. high; stems 1–5, simple, arising from tuft of basal leaves which may or may not be persistent, internodes up to 8 cm. long; basal leaves numerous, attenuate into long petioles, narrowly elliptic, 1.5–2.5 cm. long, .2–.45 cm. broad, acute; cauline leaves 2–3 pairs, sessile, subconnate, lanceolate, 1.5–3.5 cm. long, up to .4 cm. broad, 3-nerved, midvein prominent; inflorescence axillary and terminal many-flowered (6–14) subumbellate cymes; pedicels usually recurved at tip, 2.5 cm. long; calyx-lobes oblanceolate-elliptic, papillate, up to .55 cm. long, .25 cm. broad, acute, 3-nerved, reticulate at tip; corolla

.6–.7 cm. long, yellowish, tube one-half the length of the entire corolla; lobes ovate-oblong, papillate, acute, margin inrolled and erose; spurs one-fourth length of corolla, slender, slightly spreading, incurved at tip; stamens approximately .3 cm. long, attached at summit of tube; filaments linear, anthers broadly ovate; stigma only slightly reflexed, capsule up to 1 cm. long, subfalcate; seeds subglobose, reticulate, greenish yellow, brown.

Distribution: moist grassy meadows of Bolivia.

Specimens examined:

BOLIVIA: Yungas, 1890, *Bang 665* (BG TYPE, G, M, NY, US, V); Sorata, alt. 3300 m., Feb. 1886, *Rusby 669* (G, M, NY, US, V); Pongo, alt. 3800 m., July 11, 1921, *White 178* (NY TYPE of *Tetragonanthus Whitei* Rusby).

This last-cited specimen was described as *Tetragonanthus Whitei* Rusby, but accords exactly with *H. vincetoxicoides* Gilg, except for its small size.

46. H. Weberbaueri[62] Allen, n. sp.

Perennial herb, caespitose, .5–1 dm. high; root fibrous, covered with darkened remains of leaves; stems usually several, rather stout; basal leaves numerous, attenuate into long slender petioles equalling the blade in length, oblanceolate to lanceolate, 2.5–3.5 cm. long, .2–.4 cm. broad, obtuse, 3-nerved; cauline leaves sessile, 1 pair at extreme base of stem, linear-lanceolate, 3–4 cm. long, .2–.3 cm. broad, obtuse, 3-nerved; inflorescence 3–5-flowered terminal subumbellate cymes with occasional depauperate 1-flowered cymes in axils of cauline leaves, pedicels .6–2 cm. long, erect or curving at the tips; calyx-lobes broadly oblanceolate to

[62] **H. Weberbaueri** Allen, sp. nov.—Herba perennis, caespitosa, .5–1 dm. alta; radice fibrata, reliquiis foliorum tecta; caulibus plerumque pluribus, aliquid robustis; foliis basalibus multis, petiolis longis tenuibus laminae longitudini adaequantibus attenuatis, 2.5–3.5 cm. longis, .2–.4 cm. latis, obtusis, 3-nerviis; foliis caulinis, sessilibus, plerumque ad basin caulis, 1-geminis, lineari-lanceolatis, 3–4 cm. longis, .2–.3 cm. latis, obtusis, 3-nerviis; inflorescentia 3–5 florifera, terminali, subumbellata-cymosa, per occasionem depauperata 1-florifera foliorum caulinium axillibus; pedicellis .6–2 cm. longis, erectis, vel ad apicem curvatis; calycis lobis late oblanceolatis vel attenuate obovato-ellipticis, .4–.6 cm. longis, acutis vel obtusis, 3-nerviis; corolla 1.2–1.5 cm. longa, viridula; tubo circiter ½ totae corollae longitudini adaequanti; lobis ovatis, acutis, erosis; calcaribus ⅓ corollae longitudini adaequantibus, tenuibus, pendulis, saepe parum divaricatis, sed semper ad apicem incurvatis; staminibus minusquam .2 cm. longis; filamentis linearibus, antheris ovatis; capsula lanceolata, ad apicem attenuata.—PERU: rocks, Mt. Razuhuillca, Prov. Huanta, Dept. Ayacucho, alt. 4300–4500 m., Feb. 4–6, 1926, *Weberbauer 7498* (F TYPE).

narrowly obovate-elliptic, .4–.6 cm. long, acute to obtuse, 3-nerved; corolla 1.2–1.5 cm. long, greenish, tube about one-half the length of the entire corolla; lobes ovate, acute, erose; spurs one-third the length of the corolla, slender, pendulous, often slightly divaricate but always incurved at the tips; stamens less than .2 cm. long; filaments linear, anthers ovate; capsule lanceolate, attenuate at tip.

Distribution: Peru.

Specimens examined:

PERU: rocks, Mt. Razuhuillca, Prov. Huanta, Dept. Ayacucho, alt. 4300-4500 m., Feb. 4–6, 1926, *Weberbauer 7498* (F TYPE).

47. H. Stuebelii Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 110. 1916.

Biennial, up to 3–4 dm. high; stem thick, erect, simple or branching at base; basal leaves in dense rosette, narrowed at base, lanceolate, 3–3.5 cm. long, .3–.4 cm. broad, acute; cauline leaves thickly herbaceous, sessile, oblong-lanceolate, 2–5 cm. long, .3 cm. broad, the uppermost smaller, obsolete, narrowly acuminate, 5-nerved, veins sunken above, prominent below; inflorescence a terminal dense many-flowered (5–7–9) subcapitate cyme, and axillary 1–few-flowered (3, rarely 5) cymes, pedicels 1–2.7 cm. long; calyx-lobes lanceolate, .7–.8 cm. long, .25 cm. broad, acute, obsoletely 3–5-nerved; corolla almost 1 cm. long, tube approximately one-third the length of the entire corolla; lobes ovate-oblong, acute; spurs pendulous, incurved, about one-third the length of the corolla.

Distribution: Peru.

Specimens examined:

PERU: Rio Blanco, about 5000 m., May 20–25, 1923, *Macbride 3040* (F, M). (TYPE not seen, *Stübel 49e*, BG, M photo).

48. H. robusta Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 110. 1916.

Biennial herb, up to 3 dm. high; ligneous unbranched tap-root; stems 1–3, simple or branching below or above, erect, sturdy, up to .3 cm. thick, striate, internodes up to 6 cm. long; numerous basal leaves in rosette, attenuate into narrower petiole, broadly elliptic, 2–2.5 cm. long, .6 cm. broad, acute-acuminate, 3-nerved,

nerves appearing sunken from above, prominent below; cauline leaves 1–3 pairs, sessile, elliptic, up to 4 cm. long, .65 cm. broad, 3–5-nerved, acute; inflorescence axillary and terminal many-flowered (6–15) subumbelliform cymes; pedicel sturdy, slightly recurved at tip, up to 3 cm. long; calyx-lobes oblong to ovate, approximately .5 cm. long, .25 cm. broad, acute, papillate, uninerviate, tip reticulate; corolla up to .7 cm. long, yellow, tube slightly less than one-half the length of the entire corolla; lobes narrowly ovate, acute; spurs borne at the midpoint of the corolla-tube, tiny, slender, scarcely one-fourth the length of the corolla, tip incurved; stamens about .25 cm. long, inserted at the summit of the tube; filaments linear, anthers ovate-oval; capsule up to 1.3 cm. long, ovate; seeds oval, reticulate.

Distribution: near snow line in Bolivia.

Specimens examined:

BOLIVIA: near snow line, Mt. Tunari, near Cochabamba, 1891, *Bang 1019* (ANSP, BG TYPE, F, G, M, NY, US, V); Dept. Cochabamba, Prov. Chaparé, Ceja-region, La Aduana, alt. 3000 m., March 7, 1927, *Steinbach 9535* (M, NY, S).

49. H. taruga gasso Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 117. 1916.

Suffruticose perennial, ligneous, more or less decumbent, up to 1.5 dm. high; root frequently sending up one or more short sterile densely leafy stems; flowering stems simple, leafy, rather slender; basal leaves, if present, petiolate, subcoriaceous, in dense spirals about lower portion of stem, lanceolate or linear-lanceolate, up to 2 cm. long, .35 cm. broad, acute; cauline leaves more or less sessile, more linear, otherwise similar to basal leaves; inflorescence usually a terminal many-flowered (6) cyme, pedicels up to 1 cm. long; calyx-lobes oblong-elliptic, acute, 3-nerved, reticulate at tip; corolla up to 1.3 cm. long, greenish-yellow, tube approximately one-fourth the length of the entire corolla; lobes ovate, acute; spurs almost one-half the length of the corolla, slender, spreading, tip incurved or divergent; stamens about 2 cm. long; filaments linear, anthers ovate; capsule oblong-ovate, subfalcate, up to 1.3 cm. long; seeds subglobose, reticulate.

Distribution: Ecuador.

Specimens examined:

ECUADOR: Loja, alt. 3000–3500 m., *Lehmann 4378* (BG TYPE, M photo); Cañar, Sept. 15, 1918, *Rose & Rose 22674* (NY, US); Mt. Pittahum, *Jameson* (G).

50. H. gigantea[63] Allen, n. sp.

Stout coarse perennial, up to 4 dm. high; root thick, ligneous, up to .5 cm. in diameter; axis subhorizontal or horizontal, coarse, fleshy, .5–.6 cm. in diameter, covered with dense coarse black remains of leaves; stems 1–many, coarse, erect, simple, internodes up to 7 cm. long; numerous basal leaves, in dense rosette, herbaceous, narrowed into petioles equalling the blade in length, dilated and almost sheathing at the base, lanceolate, 5–10 cm. long, .6–1 cm. broad, attenuate-acuminate, 3–5-nerved; cauline leaves about 3 pairs, sessile, lanceolate, 2–3 cm. long, decreasing in length toward the summit, .5 cm. broad, acuminate, 3-nerved; inflorescence a loose terminal usually 3-flowered cyme, pedicels up to 5 cm. long, erect; calyx-lobes ovate to ovate-oblong to oblong, up to 1.5 cm. long, .5 cm. broad, acute, often with suggestion of apicule, 3–many-nerved; corolla 3–4 cm. long, light green, tube less than one-third the length of the entire corolla; lobes oblong-ovate, acute, more or less erose, frequently subapiculate; spurs coarse, about one-third the length of the corolla, pendulous, incurved, the tip heavily glandular; stamens nearly 1 cm. long; filaments linear, anthers ovate, acuminate; capsule lanceolate.

Distribution: Colombia.

Specimens examined:

Colombia: Dept. Santander, Páramo de Santurbán, near Vetas, alt. 3950–4160

[63] **H. gigantea** Allen, sp. nov.—Herba perennis, robusta, crassa, usque ad 4 dm. alta; radice crassa, lignea, usque ad .5 cm. in diametro; axe subhorizontale horizontaleve, crasso, carnoso, usque ad .5–.6 cm. in diametro, reliquiis foliorum densis crassis tecto; caulibus 1–multis, crassis, erectis, simplicibus, internodiis usque ad 7 cm. longis; foliis basalibus multis, in rosula densa, herbescentibus, petiolis laminae longitudini adaequantibus attenuatis, dilatatis et prope ad basin vaginantibus, lanceolatis, 5–10 cm. longis, .6–1 cm. latis, attenuate acuminatis, 3–5-nerviis; foliis caulinis ca. 3 geminis, sessilibus, lanceolatis, 2–3 cm. longis, decrescentibus sursum, .5 cm. latis, acuminatis, 3-nerviis; inflorescentia laxa, cymosa, terminali, plerumque 3-florifera, pedicellis usque ad 5 cm. longis, erectis; calycis lobis ovatis vel ovato-oblongis vel oblongis, usque ad 1.5 cm. longis, .5 cm. latis, acutis, saepe subapiculatis, 3–multi-nerviis; corolla 3–4 cm. longa, pallida viride; tubo minusquam ⅓ corollae longitudini adaequanti; lobis oblongo-ovatis, acutis, plus minusve erosis, saepe subapiculatis; calcaribus crassis, ca. ⅓ corollae longitudini adaequantibus, pendulosis, incurvatis, ad apicem dense glandulosis; staminibus ca. 1 cm. longis; filamentis linearibus; antheris ovatis, acuminatis; capsula lanceolata.—Colombia: Dept. Santander, Páramo de Santurbán, near Vetas, alt. 3950–4160 m., Jan. 17 1927, *Killip & Smith 17566* (M type, NY, US).

m., Jan. 17, 1927, *Killip & Smith 17566* (M TYPE, NY, US); same locality, *Killip & Smith 17521* (US); same locality, *Killip & Smith 17516* (M, NY, US).

51. **H. minima**[44] Allen, n. sp.

Small perennial, caespitose, .6 dm. or less high; root ligneous; frequently numerous short sterile leafy stems up to 2.5 cm. high; flowering stems 1–2 cm. high, erect, slender, almost scapiform, simple; basal leaves in dense rosette, thick, coarse, attenuate into petioles shorter than blades, broadly oblanceolate, less than 1 cm. long, .2–.3 cm. broad, acute, obsoletely 3-nerved; leaves of sterile branches abruptly narrowed into petioles, exceeding blades in length, elliptic, up to .8 cm. long, .2 cm. broad, acute, obsoletely 3-nerved, midvein prominent; cauline leaves 1 pair at base, a second pair subtending the inflorescence, sessile, oblanceolate, .3–.7 cm. long, .2 cm. broad, acute to acuminate, obsoletely nerved; inflorescence a 2–4-flowered terminal loose cyme, pedicels 1.5 cm. long, slightly curved at apex; calyx-lobes oblong-oblanceolate, .4–.5 cm. long, .1–.15 cm. broad, acute, obsoletely 3-nerved; corolla .6–.8 cm. long, tube one-half the length of the entire corolla; lobes ovate, acute; spurs slender, pendulous, slightly incurved, between one-third and one-half the length of the corolla; stamens about .2 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate at apex.

Distribution: Ecuador.

Specimens examined:

ECUADOR: Andes, coll. of 1855, *Couthouy* (G TYPE, NY).

[44] **H. minima** Allen, sp. nov.—Herba perennis, parva, caespitosa, .6 dm. minusve alta; radice lignea; saepe caulibus multis, brevibus, sterilibus, foliosis, usque ad 2.5 cm. altis; caulibus floriferis 1–2 cm. altis, erectis, tenuibus, prope scapiformibus, simplicibus; foliis basalibus in rosula densa, crassis, petiolis brevioribus laminis attenuatis, late oblanceolatis, minusquam 1 cm. longis, .2–.3 cm. latis, acutis, obsolete 3-nerviis; foliis ramorum sterilium petiolis longioribus laminis subito attenuatis, ellipticis, usque ad .8 cm. longis, .2 cm. latis, acutis, obsolete 3-nerviis, medio-nervo prominenti; foliis caulinis ad basin 1-geminis, alio gemine inflorescentiam subtendenti, sessilibus, oblanceolatis, .3–.7 cm. longis, .2 cm. latis, acutis vel acuminatis, obsolete 3-nerviis; inflorescentia 2–4-florifera, terminali, laxa, cymosa, pedicellis 1.5 cm. longis, ad apicem parum curvatis; calycis lobis oblongo-oblanceolatis, .4–.5 cm. longis, .1–.15 cm. latis, acutis, obsolete 3-nerviis; corolla .6–.8 cm. longa; tubo ½ corollae longitudini adaequanti; lobis ovatis, acutis; calcaribus tenuibus, pendulis, parum incurvatis, ⅓–½ corollae longitudini adaequantibus; staminibus ca. .2 cm. longis; filamentis linearibus, antheris ovatis; capsula ovata, ad apicem attenuata.—ECUADOR: Andes, coll. of 1855, *Couthouy* (G TYPE).

52. H. penduliflora Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 116. 1916.

H. Dombeyana var. α Wedd. Chlor. And. **2**: 76. 1859 pp.

Biennial, up to 3 dm. high; root fibrous, axis thick, short, covered with remains of marcescent leaves; stem single, simple, erect, curved at apex; basal leaves in loose rosette, herbaceous, petiolate, oblong-lanceolate to elliptic, 4 cm. long, .5–.6 cm. broad, acute; cauline leaves 3 pairs or so, slightly narrowed at base, but sessile, oblong, 2–3 cm. long, .5–.7 cm. broad, acute, 3-nerved; inflorescence a 7–11-flowered subumbellate terminal cyme, always pendulous, rarely an axillary small 3-flowered cyme, pedicels 1.5 cm. long; calyx-lobes oblanceolate to oblong-oblanceolate, about .8 cm. long, .2–.5 cm. broad, obsoletely 3-nerved; corolla 1–1.2 cm. long, tube scarcely one-third the length of the entire corolla; lobes ovate, acute; spurs pendulous, slightly divergent, but incurved at tips about one-third to three-fourths the length of the corolla; stamens about .4 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate at apex.

Distribution: Bolivia.

Specimens examined:

Bolivia: near Lacatia, in stony meadow, alt. 3200–3700 m., *Mandon 369* pp. (G, M photo, NY, S, V).

The specimen of *Halenia penduliflora* Gilg, based on *Mandon 369* pp., has the same floral characteristics as *silenoides* and bears the label "in graminosis," which signifies a possible ecological variation. The habit is that of typical specimens of *silenoides*, which, having grown in grassy situation, has become attenuate, with the internodes more elongate, the stem more or less decumbent. However, until more material is available the species *penduliflora* must be retained.

53. H. phyteumoides Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 112. 1916.

Perennial caespitose herb, up to 1.2 dm. high; root short, thick, densely fibrous, with very short axis; stem lateral, erect, simple, thick, angled; basal leaves in dense rosette, attenuate into long petioles equalling the blades in length, spatulate or broadly oblanceolate, up to 2.5 cm. long, .35 cm. broad, acute, obsoletely 3-nerved; cauline leaves 1–2 pairs, slightly narrowed at base, but

sessile, thick, 1–1.5 cm. long, decreasing toward the summit, .3–.4 cm. broad, acute, obsoletely 3-nerved; inflorescence a terminal 5-flowered subcapitate cyme and axillary 3-flowered cymes; pedicels strongly winged, the apical up to 1 cm. long, the laterals .5–.6 cm. long; calyx-lobes obovate-oblong, up to .4 cm. long, .2 cm. broad, acute, obsoletely 3-nerved; corolla .8 cm. long, tube slightly less than one-half the length of the entire corolla; lobes ovate-oblong, subrotund; spurs slender, pendulous, incurved, one-half the length of the corolla.

Distribution: Peru.

No specimens examined, but description compiled from original publication and photographs. (TYPE, *Philippi*, BG, M photo).

54. H. Herzogii Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 113. 1916.

Perennial caespitose herb, up to .5 dm. high; subterranean axis thick, black, branching, elongate, covered with blackened remains of leaf bases; stem curved-erect, scapiform, strongly winged, simple; basal leaves in dense rosette, thick, fleshy, attenuate into long petioles equalling the blades, spatulate or obovate-oblong to oblanceolate, up to 2.6 cm. long, .3 cm. broad, acute or more or less rounded at apex, obsoletely 3-nerved; cauline leaves 1–2 pairs, attenuate, but dilated at base and sessile, lanceolate to oblong-lanceolate, 1–2 cm. long, decreasing toward the summit, .25–.3 cm. broad, acute, obsoletely 3-nerved; inflorescence a small terminal 5-flowered subcapitate cyme; terminal pedicels 1 cm. long, lateral .5–.6 cm. long, strongly winged; calyx-lobes obovate-oblong to broadly oblanceolate, about .4 cm. long, less than .2 cm. broad, acute, obsoletely 3-nerved; corolla .6–.7 cm. long, tube about one-half the length of the entire corolla; lobes narrowly ovate, subrotund; spurs one-third to three-fourths the length of the corolla, pendulous, incurved; stamens about .15 cm. long, inserted at the orifice of the tube; filaments linear, anthers ovate; stigma truncate; capsule lanceolate.

Distribution: Bolivia.

Specimens examined:

BOLIVIA: Lagodos, alt. 4400 m., *Herzog 2377* (BG TYPE, M photo, V).

55. H. silenoides Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 113. 1916.

Halenia Dombeyana var. α Wedd., Chlor. And. **2**: 76. 1859, pp. non *Halenia gracilis* var. *Dombeyana* Griseb.

Perennial herb, for the most part less than 1.5 dm. high, seldom over 2 dm.; root thick, many branches; stems 1–6, simple, erect or very slightly decumbent, rather thick, covered with marcescent leaves at the bases; sterile stems short, densely leafy; basal leaves numerous, attenuate into long narrow petioles frequently equalling the blades, less than 2 cm. long, .35 cm. broad, acute, 3-nerved; cauline leaves 1–2 pairs, sessile, lanceolate, usually about 2 cm. long, acute, 3-nerved; inflorescence a terminal or axillary 3–10-flowered cyme, pedicels more or less erect, up to 2.5 cm. long; calyx-lobes oblong-oblanceolate, approximately .3–.5 cm. long, acute, uninerviate, densely reticulate; corolla approximately .9 cm. long, yellowish-green, tube about one-half the length of the entire corolla; spurs more than one-third the length of the corolla, slender, divergent, incurved at tips; stamens about .25 cm. long; filaments linear, anthers broadly ovate, acute; capsule up to 1.1 cm. long, narrowly ovate, attenuate at tip, subfalcate; seeds subglobose, reticulate.

Distribution: alpine meadows in Bolivia and Peru.

Specimens examined:

Bolivia: alpine meadows, Choquetanga Grande, alt. 3600 m., *Herzog 2402* (S); Unduavi, Nordyungas, 3300 m., *Buchtien 54* (F, G, NY); Unduavi, alt. 3300 m., *Buchtien 600* (US); Unduavi Valley, *Bro. Julio 338* (US); same locality, alt. 2000–2600 m., 1925, *Bro. Julio 455* (US); Pongo, alt. 4000 m., Feb. 17–March 1, 1926, *Tate 223* (NY); *Mandon 369* pp (BG type?).

Bolivia without Locality: *Cumming 128* (V).

Peru: Dept. of Cusco, Paso de Tres Cruces, Cerro de Cusilluyoc, alt. 3800–3900 m., May 3, 1925, *Pennell 13842* pp. (ANSP, US).

The specimen collected by *Tate* is rather doubtfully included. It has the habit of *silenoides*, but the flowers on the whole appear smaller, the spurs shorter and thicker, more like those of *Herzogii*. The specimens, *Pennell 13842*, found in the United States National Herbarium and the Philadelphia Academy of Natural Sciences, are certainly *H. silenoides*, but the same number located in the New York Botanical Garden Herbarium is *H. asclepiadea*.

56. H. umbellata (R. & P.) Gilg in Fedde, Rep. Spec. Nov. **2**: 53. 1906.

Swertia umbellata R. & P. Fl. Peruv. **3**: 21. *pl. 242, fig. b.* 1802.

Halenia Pavoniana G. Don, Gen. Hist. **4**: 177. 1838.

Halenia gracilis var. *β Dombeyana* Griseb. in DC. Prodr. **9**: 130. 1845.

Halenia Dombeyana Wedd. Chlor. And. **2**: 76. 1859.

Perennial herb up to 3 dm. high; root ligneous, frequently sending out short sterile densely leafy branches; stems 1–3, usually simple, erect, minutely striate, frequently branched above, the branches bearing inflorescences nearly as long as the terminal branch, marcescent leaves at base; basal leaves numerous, elliptic, attenuate into slender petioles nearly equalling blades, 2–3.5 cm. long, .6–.8 cm. broad, acute, 3-nerved; cauline leaves 2–3 pairs, attenuate into short petioles, or the extreme upper more or less sessile, lanceolate to elliptic, acute, 3-nerved; inflorescence terminal or axillary 5–14-flowered umbellate cymes, with an approach to a corymb; pedicels up to 3.5 cm. long, the center usually erect, the marginal more or less recurved and shorter; calyx-lobes obovate-elliptic, up to .6 cm. long, subacuminate, 3-nerved, reticulate at tip; corolla 1.0–1.3 cm. long, tube slightly less than half the length of the entire corolla; lobes ovate-oblong, acutish; spurs less than one-half the length of the corolla, very slender, tapering, slightly divergent; stamens .2–.25 cm. long; filaments linear, anthers broad-oblong, somewhat acute; stigma deeply cleft, slender, attenuate; capsule up to 1.5 cm. long, narrowly ovate-attenuate, subfalcate; seeds globose, reticulate.

Distribution: Andes of Peru.

Specimens examined:

PERU: Baños, *Dombey* (G, US); Agapata in Virgallis, coll. of 1854, *Lechler 2001* (DH, V); Lucumayo Valley, alt. 1800–3600 m., June 18, 1915, *Cook & Gilbert 1308* (US); Piñasniocj, Panticalla Pass, alt. 3600 m., July 14, 1915, *Cook & Gilbert 1811* (US); Mito, alt. 3000 m., July 8–22, 1922, *Macbride & Featherstone 1657* (F, M); La Quinua, alt. about 4000 m., May 14, 1922, *Macbride & Featherstone 2001* (F, M); Dept. of Cusco, Cerro de Colquipata, alt. 4100–4200 m., May 1, 1925, *Pennell 13738* (ANSP, NY, US); Dept. Puno, Prov. Sandia, alt. 2700 m., *Weberbauer 680* (DH).

PERU WITHOUT LOCALITY: *Pavon 567* (DH).

The illustration of *S. umbellata* in Ruiz & Pavon's 'Flora Peruvianae' has spurs longer than the specimens cited above but the plant is similar otherwise.

57. H. Meyeri Johannis Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 114. 1916.

Perennial herb up to 2 dm. high, though usually less than 1.5 dm.; root ligneous; stem simple, erect, rather stout base frequently covered with marcescent leaves; basal leaves, when present, in dense rosette, attenuate into petiole longer than blade, narrowly elliptic, up to 2.2 cm. long, up to .6 cm. broad, acute, 3-nerved; 1–2 pairs of cauline leaves, sessile, elliptic, up to 1.8 cm. long, about .5 cm. broad, inconspicuously 3-nerved, acute; inflorescence an axillary or terminal, 3–12-flowered cyme, loose or dense; pedicels up to 3 cm. long, usually recurved; calyx-lobes obovate-elliptic, papillate, approximately .6 cm. long, .2 cm. broad, 3-nerved, acute, reticulate; corolla up to 1.5 cm. long, yellowish, tube less than one-half the length of the entire corolla; lobes ovate-acute; spurs one-third to almost one-half the length of the corolla, rather thick, tapering, incurved; stamens about .5 cm. long; filaments linear, anthers ovate; capsule ovate, attenuate, about 1.5 cm. long.

Distribution: páramos of Ecuador.

Specimens examined:

ECUADOR: Sangai, *Karsten* (V); Azuay, *Spruce 5131* (V); Quitensian Andes, coll. of 1855, *Couthouy* (F); Farm of Antesiana, Nov. 2, 1858, *Jameson* (ANSP); same locality, alt. 5000 m., Oct. 1923, *Anthony & Tate 299* (US); Rucu-Pichincha, Aug. 1923, *Anthony & Tate 182* (US); Prov. Carchi, páramos 12 miles west of Tulcán, alt. 3300 m., Aug. 10, 1923, *Hitchcock 20909* (G, NY, US); Chimborazo, *Hans Meyer 113* (BG TYPE).

58. H. barbicaulis Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 112. 1916.

Annual herb, up to 2 dm. high; flowering stem seemingly erect, simple below, frequently branched above, branches erect, about .2 cm. thick, densely leafy, 4-alate, densely, long-ciliate below each node; internodes 2–4 cm. long; cauline leaves herbaceous, narrowed into broad ciliolate petioles, oblong, up to 2 cm. long, .5–.6 cm. broad, acute or very acute, subapiculate, 5-nerved, veins inconspicuous above, prominent beneath, loosely reticulate; inflorescence a terminal dense many-flowered (7–9) subumbellate cyme, or 3-flowered axillary cymes; pedicels of apical flowers 3–4 cm. long, lateral 2 cm. or less, all winged; calyx-lobes obovate-oblong, .6–.7 cm. long, .35–.4 cm. broad, apiculate, obsoletely 3-nerved; corolla about 1 cm. long, tube over one-third the length of the entire corolla; lobes ovate, subrotund, erose; spurs almost

one-half the length of the corolla, pendulous, divaricate; stamens .2–.3 cm. long; anthers ovate-oblong.

Distribution: Peru.
Specimens examined:
PERU: Chacapoyas, Dec. 1846, *Mathews* (DH TYPE).

59. **H. Rusbyi** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 117. 1916.

Perennial herb up to 3 dm. high; root strong, thick, ligneous, frequently horizontal, curved at the apex, sending up one or more simple erect flowering stems, bearing marcescent leaves at the base, or short densely leafy sterile branches; basal leaves slightly narrowed into broad petioles as long as the leaf blades, elliptic, frequently up to 3 cm. long, acute, 3-nerved; cauline leaves 1–4 pairs, becoming sessile toward the summit of the stem, up to 3 cm. long, oblong-lanceolate, attenuate, acuminate; inflorescence terminal and axillary many-flowered umbelliform cymes; pedicels erect, up to 2 cm. long; calyx-lobes narrowly ovate, up to .7 cm. long, acute, 3-nerved; corolla up to 1.4 cm. long, tube .25–.3 cm. long; lobes ovate, acute; spurs approximately one-half or slightly more than one-half the length of the corolla, almost horizontally divergent, often with the tips incurved; stamens about .35 cm. long; filaments linear, anthers broadly ovate; capsule up to 1.5 cm. long, ovate-lanceolate, subfalcate; seeds ovoid.

Distribution: Bolivia.
Specimens examined:
BOLIVIA: Unduavi, alt. 3300 m., Oct. 1885, *Rusby 670* (ANSP, G, M, NY, US, V TYPE).

Similar to *H. Purdieana*, but a sturdier plant with broader flowers, spurs more divergent and more strongly recurved at tip, stem thicker, and leaves larger.

60. **H. Purdieana** Wedd. Chlor. And. **2**: 76. *pl. 53 A*. 1859.

Perennial herb, up to 2.5 dm. high; root ligneous; sterile stems 1–3, short, leafy; fertile stems probably more than one, simple, erect, slender; basal leaves in dense rosette, attenuate into slender petioles nearly equalling the blades in length, lanceolate to linear, up to 1.5 cm. long, .3 cm. broad, acute, obscurely 3-nerved, mid-vein prominent; cauline leaves 3–5 pairs, at intervals of about 4 cm., more or less closely appressed, practically sessile, linear,

attenuate, 2 cm. or less long, acuminate; inflorescence a terminal, rarely axillary as well, 1–5-flowered cyme; pedicels up to 2.5 cm. long, recurving conspicuously at tip; calyx-lobes lanceolate, up to .7 cm. long, attenuately acuminate, 3-nerved; corolla up to 1.8 cm. long, greenish-white (fide *Killip & Smith 18665*, corolla-tube and lobes greenish-white, spurs white; *Linden 729*, fl: blanches), tube less than one-third the length of the entire corolla; lobes ovate, acute, erose; spurs nearly one-half the length of the corolla, slender, tapering, divergent, but slightly depressed at tip; capsule approximately 1.4 cm. long, ovate, attenuate at tip.

Distribution: Colombia.

Specimens examined:

COLOMBIA: Prov. de Pamplona, Páramo de las Cruces, alt. 3000 m., Nov. 1842, *Linden 729* pp. (BG TYPE, DH, M photo, V); "Dept. Norte de Santander: between Mutiscua and Pamplona," alt. 3400 m., Feb. 23, 1927, *Killip & Smith 19723* (US); "Dept. Norte de Santander: Páramo de Romeral," alt. 3800–4200 m., Jan. 30, 1927, *Killip & Smith 18665* (US); "Dept. Santander: Páramo de las Puentes," above La Baja, alt. 3500–3700 m., Jan. 25, 1927, *Killip & Smith 18229* (US); "Dept. Santander: Páramo de Romeral," alt. 3800–4000 m., Jan. 29–30, 1927, *Killip & Smith 18548* (NY, US); same locality, 3800–4200 m., Jan. 30, 1927, *Killip & Smith 18644* (US); same locality and date, *Killip & Smith 18688* (US); Páramo de las Coloradas, above La Baja, alt. 3900–4100 m., Jan. 27, 1927, *Killip & Smith 18426* (M, NY, US); same locality and date, *Killip & Smith 18466* (NY, US); western slope of Páramo Rico, alt. 3600 m., Jan. 15–19, 1927, *Killip & Smith 17722* (US).

The majority of the specimens collected by *Killip & Smith* vary from the typical members of the species only in that the spurs are slightly more pendulous. The habit is similar. This difference is not considered of varietal importance, hence the specimens are placed in the species proper. The species *H. Purdieana* has a marked resemblance in habit and in the color of the flower to *H. Pringlei* of Mexico, but the spurs are not reflexed to the extent they are in the former.

60a. H. Purdieana var. **congesta**[65] Allen, n. var.

Plant shorter than the species, not more than 1 dm., usually less than .5 dm., high; root heavy, extremely ligneous; stems 1–

[65] **H. Purdieana** var. **congesta** Allen, var. nov.—Planta speciei breviora, non plusquam 1 dm. alta, plerumque minusquam .5 dm. alta; radice crassa, lignissima; caulibus 1–multis, erectis, simplicibus; foliis basalibus speciei pluribus, in rosula densissima, subcoriaceis, linearibus vel lineari-lanceolatis, minusquam 1.5 cm. longis; foliis caulinis 1–2 geminis, lineari-lanceolatis, adpressis; inflorescentia speciei simili.—COLOMBIA: Dept. Santander, Páramo de Santurbán, near Vetas, alt. 3950–4160 m., Jan. 17, 1927, *Killip & Smith 17568* (M TYPE, NY, US).

many, erect, simple; basal leaves more numerous than in the species, and in very dense rosettes, subcoriaceous, linear to linear-lanceolate, less than 1.5 cm. long; cauline leaves 1–2 pairs, linear-lanceolate, very closely appressed; inflorescence similar to that of species.

Distribution: known only from the Dept. of Santander, Colombia.

Specimens examined:

COLOMBIA: "Dept. Santander: Páramo de Santurbán," near Vetas, alt. 3950–4160 m., Jan. 17, 1927, *Killip & Smith 17568* (M TYPE, NY, US); same locality and date, *Killip & Smith 17485* (NY, US); Páramo Frailejonale, near Vetas, alt. 3750–3850 m., Jan. 21, 1927, *Killip & Smith 17982* (NY, US); Páramo de Mogotocoro, near Vetas, alt. 3700–3800 m., Jan. 18, 1927, *Killip & Smith 17604* (NY, US); Páramo Rico, near Vetas, alt. 3750–3850 m., Jan. 18, 1927, *Killip & Smith 17662* (M, NY, US); Páramo de las Vegas, alt. 3700–3800 m., Dec. 20–21, 1926, *Killip & Smith 15680* (US); Páramo de Santurbán, en route from Tona to Mutiscua, alt. 3800–4300 m., Feb. 18, 1927, *Killip & Smith 19551* (US).

61. **H. Hieronymi** Gilg in Fedde, Rep. Spec. Nov. 2: 52. 1906.

Annual, up to 3.5 dm. high; stem single, simple, erect; basal leaves few, in a rather loose rosette, petiolate, oblanceolate, up to 2.5 cm. long, .25 cm. broad; cauline leaves 4–5 pairs, membranaceous, sessile, lanceolate, 1.5–5 cm. long, .3–.9 cm. broad, acute, obsoletely 3-nerved; inflorescence a terminal 5–6-flowered subumbelliform cyme, or often solitary axillary flowers, pedicels up to .7 cm. long; calyx-lobes oblanceolate, .6–.7 cm. long, .2 cm. broad, acute; corolla about 1 cm. long, yellow-green; lobes ovate, acute; spurs nearly one-half the length of the corolla, pendulous, slightly spreading.

Distribution: Argentina.

No specimens examined, but description compiled from original publication and photograph. (TYPE, *Fiebrig 2645*, BG).

62. **H. bifida**[66] Rusby & Allen, n. sp.

Perennial, up to 3 dm. high; root thick, ligneous; stem single, simple, erect, rather stiff, stout, winged; basal leaves in a dense

[66] H. bifida Rusby & Allen, sp. nov.—Herba perennis, usque ad 3 dm. alta; radice crassa, lignea; caule solitario, simplice, erecto, paulo rigido, robusto, alato; foliis basalibus, in rosula densa, rigidis, petiolatis, oblanceolatis, usque ad 4.5 cm. longis, .4 cm. latis, acutis vel subito acuminatis, 3-nerviis; foliis caulinis 3–4 geminis, sessilibus, lanceolatis, 2–3 cm. longis, decrescentibus sursum, .3 cm. latis, acuminatis, 3-nerviis, medio-nervo infra prominenti, supra immerso; inflorescentia multo-flor-

rosette, stiff, petiolate, oblanceolate, up to 4.5 cm. long, .4 cm. broad, acute to abruptly acuminate, 3-nerved; cauline leaves 3–4 pairs, sessile, lanceolate, 2–3 cm. long, decreasing toward the summit, .3 cm. broad, acuminate, 3-nerved, midvein prominent below, sunken above; inflorescence a many-flowered terminal subumbellate cyme, frequently fewer-flowered cymes in axils of upper leaves; pedicels up to 3 cm. long; calyx-lobes broadly oblanceolate, .5 cm. long, .15 cm. broad, acute, obsoletely 3-nerved; corolla up to 1.3 cm. long, tube one-third the length of the entire corolla; lobes ovate, more or less acute, apiculate, erose; spurs more than ½ the length of the entire corolla, slender, tapering, pendulous, spreading, incurved at tip; stamens .25 cm. long; filaments linear; seeds ovoid, dark brown.

Distribution: Bolivia.
Specimens examined:
BOLIVIA: Cocopunco, alt. about 3000 m., March 24–30, 1926, *Tate 379* (NY TYPE).

63. H. Weddelliana Gilg in Engl. Bot. Jahrb. **25**: 724. 1898; **54**: Beibl. 118, p. 118. 1916.

H. antigonorrhoica Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 119. 1916.

Perennial herb from 1.5–3 dm. high; root fibrous; subterranean stem more or less elongate, densely covered with remains of marcescent leaves, horizontal, more or less erect, many-stemmed; sterile stems leafy, numerous; flowering stems numerous, curved or erect, the lower part densely leafy, the upper loosely leafy, internodes 2–8 cm. long; basal leaves numerous, in rosette, narrowly petiolate, subconnate, spatulate to oblong-lanceolate, 1–3 (rarely 5) cm. long, .2–.6 cm. broad, acute, 3-nerved; cauline leaves subconnate, lanceolate to oblong-lanceolate, 1–2 (rarely 6) cm. long, .2–.6 cm. broad, acute, 3-nerved; inflorescence usually terminal, occasionally lateral, subumbellate or subcapitate many-

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ifera, terminali, subumbellato-cymosa; saepe cymis pauciore-floriferis in superiorum foliorum axibus; pedicellis usque ad 3 cm. longis; calycis lobis late oblanceolatis, acutis, obsolete 3-nerviis, ca. .5 cm. longis, .15 cm. latis; corolla usque ad 1.3 cm. longa; tubo ⅓ totae corollae longitudini adaequanti; lobis ovatis, plusminusve acutis, apiculatis, erosis; calcaribus tenuibus, plusquam ½ totae corollae longitudini adaequanti, attenuatis, pendulis, divaricatis, ad apicem incurvatis; staminibus .25 cm. longis; filamentis linearibus; seminibus ovoideis, brunneis.—BOLIVIA: Cocopunco, alt. about 3000 m., March 24–30, 1926, *Tate 379* (NY TYPE).

flowered cymes; pedicels .3–.8 cm. long, the central one longer; calyx-lobes obovate-oblong to oblong, .5–.8 cm. long, acuminate or acute, obsoletely 3-nerved; corolla 1.2–1.5 cm. long, yellow-green, tube less than one-half the length of the entire corolla; lobes ovate, acute to subrotund, entire or crenulate, erose; spurs one-half (rarely three-fourths) the length of the corolla, subhorizontally divaricate but incurved at the apex; stamens .25–.35 cm. long; filaments linear usually, anthers ovate; capsule lanceolate-ovate.

Distribution: mountains of Colombia, Ecuador, and Peru.

Specimens examined:

COLOMBIA: near Pasto, alt. 3600 m., June 13, 1878, *Lehmann* (V); páramos of Guanacas, Prov. Popayan, *Lehmann 809* (NY); same locality, *Lehmann 6128* (BG TYPE, F, US); same locality, *Hartweg 1255* (NY, V TYPE of *H. antigonorrhoica* Gilg); grassy páramo, Paletara, Dept. of Cauca, June 15–17, 1922, *Pennell 6929* (ANSP, G, NY, US); same locality, alt. 2950 m., 1884, *Lehmann 3498* (US).

ECUADOR: Andes, Quito, alt. 4000 m., April 1864, *Jameson* (V); pasture of the Andes, alt. 4000 m., March 1859, *Jameson* (NY, US, V); 1859, *Jameson* (BG G, M photo, UC); without locality or date, *Jameson* (NY, US); Quitian Andes, *Jameson* (V); Andes, Quito, 1855, *Couthouy* (ANSP, G, NY); same locality, 1857–9, *Spruce 5131* (G, UC, V); San Ignacio, Pichincha Region, alt. approximately 4000 m., Aug. 14–19, 1923, *Anthony & Tate 133* (US); Pichincha, alt. 3500 m., Feb. 3, 1927, *Firmin 5* (US); Pichincha-Quito, *Karsten* (V); same locality, Dec. 30, 1929, *Heilborn 137* (S); Tunguragua, above Baños, alt. 2000 m., Feb. 27, 1920, *Holmgren 378* (S); Cotopaxi, alt. 3000–4000 m., Dec. 27, 1879, *Lehmann* (V); without locality, *Gesner* (UC); Mt. Chimborazo, alt. 4200 m., *Rimbach 154* (US, M); "in pascuis andinis, alt. 2800–4000 m.," *Sodiro 109* (BG, TYPE of *H. Weddelliana* Gilg).

PERU: grassy places in shrub-wood, Putis, Choimacota Valley, Prov. Huanta, Dept. Ayacucho, alt. 3400–3500 m., Feb. 27–March 12, 1926, *Weberbauer 7524* (F); Tambo de Vaca, alt. about 4000 m., June 10–24, 1923, *Macbride 4362* (F, M).

64. H. elegans[67] Allen, n. sp.

Stout perennial, up to 4 dm. high; root thick, fibrous; axis covered with blackened remains of leaf bases, erect, sometimes

[67] **H. elegans** Allen, sp. nov.—Herba perennis, usque ad 4 dm. alta; radice crassa, fibrata; axe foliorum reliquiis tecto, erecto, saepe plus minusve decumbenti; ramis brevibus sterilibus, dense foliosis, 10–12 cm. altis; caule solitario, florifero, crasso, .5–.6 cm. in diametro, infra simplice, supra parum ramoso, striato; foliis basalibus in rosula densa, petiolatis, late lanceolatis, 7–9 cm. longis, acuminatis, prominenti 3-nerviis, nervis supra immersis, infra prominenti; foliis caulinis 4–6 geminis, sessilibus, 2–4 cm. longis, sursum decrescentibus; inflorescentia cymosa, laxa, multoflorifera, terminali vel ramis brevibus clause adpressis terminatis, laxis spicis similibus; pedicellis usque ad 4 cm. longis, ad apicem parum curvatis; calycis lobis foliosis, late lanceolato-ellipticis vel ovatis, 1–1.2 cm. longis, .4 cm. latis, attenuate acuminatis, prominenti 3-nerviis; corolla 3–4 cm. longa, viride, tubo ⅙–¼ corollae longitudini adaequanti; lobis obovato-ovatis, erosis, apiculatis; calcaribus prope ½

more or less decumbent; short sterile branches, densely leafy, 10–12 cm. high; single flowering stem, coarse, .5–.6 cm. in diameter, simple below, slightly branched above, striate; basal leaves in dense rosettes, petiolate, broadly lanceolate, 7–9 cm. long, acuminate, prominently 3-nerved, nerves sunken above, prominent below; cauline leaves 4–6 pairs, sessile, 2–4 cm. long, decreasing toward the summit; inflorescence loose, many-flowered, terminal cymes, or cymes terminating the short, closely appressed branches, giving the inflorescence a loose, spike-like appearance; pedicels up to 4 cm. long, slightly curved at the tip; calyx-lobes foliaceous, broadly lanceolate-elliptic or ovate, 1–1.2 cm. long, .4 cm. broad, attenuate-acuminate, prominently 3-nerved; corolla 3–4 cm. long, green, tube one-sixth to one-fourth the length of the entire corolla; lobes obovate-ovate, erose, apiculate; spurs nearly one-half the length of the corolla, slender, with tips extremely glandular, pendulous, curved outward, somewhat spreading, approximate at base; stamens about 1 cm. long; filaments linear, anthers narrowly ovate; capsule attenuate-ovate.

Distribution: Colombia.

Specimens examined:

COLOMBIA: Dept. Santander, Páramo de Romeral, alt. 3800–4100 m., Jan. 29–30, 1927, *Killip & Smith 18568* (M TYPE, NY, US).

65. H. Hoppii Reimers in Engl. Bot. Jahrb. **62**: 335. 1929.

Perennial about 1 dm. high; flowering stem simple, erect, rather stout; basal leaves in a dense rosette, herbaceous, petiolate, oblanceolate, 3 cm. long, .4 cm. broad, acute, nerved; cauline leaves 1–2 pairs, similar to a rosette, but petioles shorter; inflorescence a terminal, many-flowered cyme; pedicels 1–3 cm. or more long; calyx-lobes ligulate to elliptic, .6 cm. long, .2 cm. broad, acute at apex, subapiculate, obsoletely 3-nerved; corolla 1 cm. or less long, yellow-green, tube about one-third the length of the entire corolla; lobes acutish ovate, subrotund; spurs very slender, one-third to one-half the length of the corolla, pendulous, divergent at apex; stamens .35 cm. long.

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corollae longitudini adaequanti, tenuibus, ad apicem glandulosis, pendulis, curvatis extrinsecis divergentioribus ad basin approximatis; staminibus ca. 1 cm. longis; filamentis linearibus; antheris attenuate ovatis; capsula attenuata-ovata.—COLOMBIA: Dept. Santander, páramo de Romeral, alt. 3800–4100 m., Jan. 29–30, 1927, *Killip & Smith 18568* (M TYPE, NY, US).

Distribution: Colombia and Peru.
Specimens examined:
COLOMBIA: (TYPE not seen, *Hopp 33a* BG, M photo).
PERU: Cuzco, alt. 3000–3600 m., July 1923, *Herrera* (US).

66. H. asclepiadea (HBK.) G. Don, Gen. Hist. **4**: 177. 1838; Griseb. Gen. & Sp. Gent. 326. 1839; in DC. Prodr. **9**: 129. 1845 pp; in Linnaea **22**: 45. 1849; Benth. Pl. Hartw. 228. 1846; Wedd. Chlor. And. **2**: 75. 1859, pp.

Swertia asclepiadea HBK. Nov. Gen. & Sp. Pl. **3**: 175. 1818.

S. quadricornis Willd. ex Roem. & Schult. Syst. Veg. **6**: 134. 1820; fide Gilg, *l. c.*

Perennial herb, up to 4 dm. high; fertile stems one or more, simple, erect; one to several short densely leafy sterile stems arising from the root or, rarely, from the base of a flowering stem; basal leaves attenuate into a more or less slender elongate petiole, narrowly lanceolate, 3–4 cm. long, up to .5 cm. broad, attenuate-acuminate, 3-nerved; cauline leaves sessile, more elongate than the basal leaves but otherwise similar to them; inflorescence a terminal or axillary, 3–8-flowered, occasionally umbelliform cyme, petioles up to 3.5 cm. long; calyx-lobes broadly lanceolate, up to .6 cm. long, acute, 3-nerved; corolla approximately 1.2–1.3 cm. long, greenish-yellow, tube one-fourth the length of the entire corolla; lobes broadly ovate, acute; spurs horizontal, measuring up to 1.7 cm. from tip to tip; stamens approximately .45 cm. long; filaments linear, anthers ovate; capsule up to 1.8 cm. long, ovate, attenuate at tip, subfalcate; seeds oval-elliptic, reticulate.

Distribution: Colombia, Ecuador, and Peru.
Specimens examined:
COLOMBIA: Dept. of Cundinamarca, above Bogota, bushy slope, alt. 2700–2800 m., Aug. 16, 1917, *Rusby & Pennell 1269* (NY); Páramo de Guasca, July 21, 1919, *Bro. Ariste-Joseph A390* (US); mountains near Bogota, Oct. 20, 1852, *Holton 468* (ANSP, DH, G, NY); páramos, Bogota, March 1916, *M. T. Daire 123* (US); Bogota, alt. 2900 m., *Karsten* (V); Bogota, alt. 3000 m., 1851–57, *Triana 1958* (V); near Bogota, *Goudot* (DH); Andes near Bogota, 1843, *Hartweg 1254* (DH, NY, V); same locality, *Bro. Ariste-Joseph* (US); Pamplona, Páramo de las Cruces, alt. 3600 m., Nov. 1842, *Linden 729* pp. (DH, V); Tequendama, 1917, *Bro. Ariste-Joseph A46* (G, US); páramos, Guasca, alt. 4000 m., Aug. 1931, *Arbelaez 1201* (US); (TYPE not seen, *Humboldt & Bonpland*, HJP, M, photo).
ECUADOR: Prov. Loja, between San Lucas and Oña, alt. 2200–3100 m., Sept. 7, 1923, *Hitchcock 21539* (G, NY, US).
PERU: Dept. of Cusco, Paso de Tres Cruces, Cerro de Cusilluyoc, alt. 3800–3900 m., May 3, 1925, *Pennell 13842* pp. (NY).

This species is closely related to *H. recurva* of southwestern United States and Mexico.

67. H. Kalbreyeri Gilg in Engl. Bot. Jahrb. **54:** Beibl. 118, p. 120. 1916.

Perennial caespitose herb up to 2.5–4 dm. high; axis procumbent, slender, subligneous, the upper part erect; stems 1–several, erect, more or less slender, simple, internodes 3.5 cm. long; sterile stems up to 7–8 cm. high, densely leafy above; rosette leaves petiolate, herbaceous, stiffly erect, never drooping, oblanceolate, about 5 cm. long, .3 cm. broad, acute, 3-nerved, midvein heavy and hard; cauline leaves often as many as 8 pairs, sessile, linear-lanceolate to lanceolate, up to 2.5 cm. long, .2–.25 cm. broad, acute, 3-nerved; inflorescence terminal or axillary cymes, 1–5-flowered, frequently pseudo-spicate or pseudo-paniculate, pedicels up to 3 cm. long; calyx-lobes lanceolate, up to .5 cm. long, .15 cm. broad, 3-nerved; corolla 1.2–1.5 cm. long; tube one-third the length of the entire corolla; lobes ovate, somewhat acute, erose; spurs one-half to three-fourths the length of the corolla; stamens about .4 cm. long; filaments linear, anthers broadly ovate; capsule lanceolate.

Distribution: Colombia.

Specimens examined:

COLOMBIA: Páramo de Choavhi, near Bogota, alt. 3700 m., Aug. 8, 1922, *Killip & Bro. Ariste-Joseph 11924* (ANSP, US); Dept. Cusco, La Raya, April 22, 1925, *Pennell 13513* (ANSP); Dept. Norte de Santander, between Mutiscua and Pamplona, alt. 3400 m., Feb. 23, 1927, *Killip & Smith 19723* (US). (TYPE not seen, *Kalbreyer 717*, BG, M photo).

68. H. bella Gilg in Fedde, Rep. Spec. Nov. **2:** 52. 1906.

Perennial herb, 2–2.5 dm. high; stems decumbent, bearing at apex numerous short sterile leafy branches up to 10 cm. long, and elongate fertile branches, simple, erect, more or less slender, internodes up to 6 cm. long; basal leaves numerous, subcoriaceous, petiolate, oblanceolate to lanceolate, 3–3.5 cm. long, .4 cm. broad, acute, 3–5-nerved, veins sunken above, prominent below; leaves of sterile branches lanceolate, acute; cauline leaves 3–4 pairs, sessile, lanceolate, acute; inflorescence a terminal subumbelliform many-flowered cyme, rarely axillary 3-flowered cymes; calyx-lobes obovate-lanceolate, .6–.7 cm. long, .2 cm.

broad, acute, nerved; corolla approximately 1.6 cm. long, green; lobes obovate, acute; spurs horizontal or subhorizontal, about three-fourths the length of the corolla.

Distribution: Peru.

Specimens examined:

PERU: Dept. Junín, Prov. Tarma, Huacapistana, alt. 3000–3100 m., *Weberbauer 2065* (BG TYPE, DH, M photo); *Pavon 737* (DH).

69. **H. sphagnicola** Gilg in Engl. Bot. Jahrb. **54**: Beibl. 118, p. 121. 1916.

Perennial, about 2.5 dm. high; root slender, multifibrous; axis short, slender, nearly erect; several curved-ascending sterile branches; fertile branches single, simple or branched at base, erect, the lower portion densely leafy, the upper loosely leafy; basal leaves in rosette, herbaceous, attenuate into petioles once or twice the length of the blades, obovate, 1.5–2.2 cm. long, .5 cm. broad; lower cauline leaves several pairs, petiolate, obovate, 1.5–2 cm. long, .3 cm. broad, acute; upper cauline leaves slightly narrowed at base but more or less sessile, oblong or oblong-lanceolate, .7–1.2 cm. long, .2–.25 cm. broad, acute to acuminate, obsoletely 3-nerved; inflorescence a terminal many-flowered subglobose cyme; pedicels about 1–1.3 cm. long; calyx-lobes obovate to ovobate-oblong, scarcely .3 cm. long, .1–.15 cm. broad, subrotund at apex, obsoletely 3-nerved; corolla .8–.9 cm. long, sulphur-yellow, tube less than one-half the length of the entire corolla; lobes ovate, rotund; spurs slender, tapering, one-half the length of the corolla, but subhorizontally divaricate, often curved upward at the apex.

Distribution: Peru.

No specimens examined, but description compiled from original publication and photograph. (TYPE, *Weberbauer 4376*, BG, M, photo).

LIST OF EXSICCATAE

The distribution numbers are printed in *italics*. Unnumbered collections are indicated by a dash. The numbers in parentheses are the species numbers used in this monograph.

Aiton, G. B. — (23).
Alaman, L. — (2a).
Allen, J. A. — (23).
Altamirano, F. *908* (21).
Andrieux, G. *226* (31).
Anthony, H. E. & Tate, G. H. H. *133* (63); *182*, *299* (57).
Arbelaez, E. P. *1201* (66).

Archer, W. A. *1348* (2).
Ariste-Joseph, Bro. —, *A46* (66); *A423* (10); *A390* (66).
Arnold, I. S. — (23).
Arsène, Bro. G. — (2a); — (2d); — (31a); *87* (23); *55* (2d); *1703*, *1711* (2a); *2098* (2); *5610* (2a); *5864*, *5957* (2d).
Bailey, W. W. — (23).
Bang, M. *665* (45); *1019* (48).
Banks, J. — (23); — (23a).
Bergman, H. F. *2948* (23).
Berlandier, J. L. *1207* (2, 2a).
Beyrich, H. K. — (2a).
Blake, J. — (23).
Blumer, J. C. *1359* (22).
Boott, W. — (23).
Bourgeau, E. — (23); *799*, *3128* (2a).
Bowdoin College, *290* (23a).
Boyce, T. E. — (23).
Brenton, M. E.— (23); *144a?* (23a).
Brinkman, A. H. *3678* (23).
Brown, S. *667* (23).
Buchtien, O. *54*, *600* (55); *1484* (35).
Burglehaus, F.— (23).
Canby, W. M. — (23).
Chapman, A. W. — (23).
Churchill, J. R. — (23).
Chute, A. P. — (23).
Collins, J. F., Fernald, M. L. & Pease, A.S. —, *4261* (23).
Conzatti, C. *2295*, *4265* (26).
Conzatti, C. & Gonzalez, V. *878* (2b).
Cook, O. F. *45* (32a).
Cook, O. F. & Gilbert, G. B. *1308* (56); *1793* (36); *1811* (56).
Coulter, T. *939* (31).
Couthouy, J. P. — (51); — (57); — (63).
Cristan, F. — (24).
Cumming, H. *128* (55).
Daire, M. T. *123* (66).
Dodge, C. K. *352* (23).
Dombey, J. — (56).
Don, D. — (31).
Drexter, C. — (23).
Drummond, J. — (23).
Eames, E. A. — (23).
Eames, E. H. & Godfrey, C. C. *8030* (23a).
Eggleston, W. W. —, *3051* (23); *10774*, *15781*, *17137* (22).
Eggleston, W. W. & Fernald, M. L. — (23).
Ehrenberg, K. *608* (30).
Ellis, C. C. *20* (22).
Endlich, R. *53* (22).
Farr, E. M. — (23).
Farwell, O. A. *249*, *770* (23).
Faxon, C. E. — (23).
Fellows, D. W. — (23).
Fernald, M. L. —, *87*, *1151* (23).
Fernald, M. L. & Collins, J. F. *244* (23).
Fernald, M. L., Dodge, C. W. & Smith, L. B. *25986* (23).
Fernald, M. L. & Long, B. *14390*, *14392* (23); *28950* (23a).
Fernald, M. L., Long, B. & Dunbar, B. H. *26982*, *26983*, *26984*, *26985*, *26986* (23a).
Fernald, M. L., Long, B. & Fogg, J. M. *381*, *382* (23a).
Fernald, M. L. & Pease, A. S. *16624* (23).
Fernald, M. L. & Wiegand, K. M. *3908*, *3909*, *6081* (23a).
Fernald, M. L., Wiegand, K. M. & Kittredge, J. *3910* (23a); *3911* (23); *3912* (23a).
Fernald, M. L., Wiegand, K. M. & Long, B. *28951* (23a).
Firmin, Fr. G. *5* (63); *697* (42).
Forbes, F. F. — (23).
Fowler, J. — (23).
Franklin & Douglas — (23).
Friedrichstahl, E. — (24).
Funck, N. *415* (15).
Funck, N. & Schlim, L. J. *901* (7); *1148* (8).
Galeotti, H. *1488* (30); *1489* (26); *1490* (2b); *7166* (33); *7219* (2); *7220* (30); *7221* (1); *7222* (31).
Garcia, P. Ibana — *410* (25).
Gates, F. C. *14156* (23).
Gates, F. C. & M. T. *9768*, *10716* (23).
Gehriger, W. *92a* (8).
Gesner, — (63).
Ghiesbreght, A. *137*, *618* (2).
Goderiels, — (23).
Goodale, G. L. — (23).

Marie-Victorin, Bro. *28*, *8349* (23).
Marie-Victorin, Bro., Brunel, J. B., Rolland-Germaine & Rousseau, Z. *17663* (23).
Marie-Victorin, Bro., & Rolland-Germaine, *9647*, *9881*, *18482* (23a); *27159* (23).
Marie-Victorin, Bro., Rolland-Germaine & Louis-Marie, *21076* (23).
Martin, — (23).
Mathew, G. F. — (23).
Mathews, A. — (58); *523* (44); *3133* (2).
Maxon, W. R. & Hay, R. *3675* (28).
Mell, P. H. & Knopf, — (23).
Metcalfe, O. B. *501* (22).
Mexia, Y. *2693* (31).
Millspaugh, C. F. *82* (23).
Moore, A. H. *1211* (23).
Morison, — (23a).
Morton, J. A. — (23).
Muller, F. — (2d).
Murdock, J. *3072* (23).
Mutis, J. C. — (22).
Nelson, E. W. *636* (30, 33); *652* (30); *698* (33); *1096* (30); *1115*, *1164*, *1340* (26); *1748* (30); *2126* (2b); *3646a* (34); *4798* (25); *4868* (22).
Nichols, G. E. *1901* (23a).
Northrup, J. I. *69* (23).
Oakes, W. — (23).
Oersted, A. S. *10772*, *10773* (24); —, *10779* (2).
Olson, — (23).
Over, W. H. *16145* (23).
Palmer, E. — (2f); *160* (2b); *359* (25); *403* (2e); *680*, *685* (2b); *839* (22).
Parry, C. C. — (23).
Parry, C. C. & Palmer, E. *600* (2); *600b* (2b).
Pavon, J. A. — (2); *567* (56); *737* (68).
Pease, A. S. *1081*, *1082* (23); *2384* (24); *2910*, *18030*, *18058* (23).
Peck, C. H. — (23).
Pennell, F. W. *2434* (2); *2438* (19); *3001* (14); *4268* (13); *6889* (2); *6929* (63); *7034* (19); *7052* (12); *7154* (2); *10575* (19); *13513* (67); *13738* (56); *13749* (37); *13842* (55); *14678* (44).
Pennell, F. W. & Hazen, T. E. *9841*, *9894* (16); *9997* (14).
Pennell, F. W. & Killip, E. P. *6480* (2).
Percival, Mrs. — (23).
Pickering, C. — (23).
Pinkerton, M. E. & Allen, C. K. — (23).
Pittier, H. *39* (32); *744* (24); *1111* (14); *2975*, *3499* (24); *13076* (24b).
Pittier, H. & Tonduz, A. *10805* (24).
Poggenburg, J. F. — (23).
Porter, T. C. — (23).
Priest, M. E. — (23a).
Pringle, C. A. — (2c); — (31a); — (22); — (23); *1329* (22); *1330* (2e); *1663* (22); *1664* (2e); *2735* (2b); *4209* (21); *4224* (31a); *4229* (20); *4720* (31a); *4908* (26); *5465* (22); *6964*, *7918*, *7943* (2c); *8939* (27); *11033* (31); *11339* (2c); *11636* (2b); *11842* (2c); *13120* (2a); *13121* (21); *13588* (22); *13971* (23).
Pringle, C. A. & Hosford, F. H. — (23).
Puckner, W. A. — (23).
Pulling, H. E. — (23).
Purpus, C. A. — (2a); *318* (20); *1760* (30); *1761* (2c); *1762* (2a); *2697* (2); *2766* (31); *3070* (30); *6011* (27).
Reiche, C. *36 ?* (21).
Richards, G. H. — (23).
Rimbach, A. *154* (63).
Robbins, W. W. *102*, *95* (23).
Robinson, B. L. *384* (23); *410* (23a).
Robinson, B. L. & Schrenk, H. *180* (23a).
Root, D. J. — (23).
Rose, J. N. *2732*, *2962* (2b).
Rose, J. N. & G. *22674* (49).
Rose, J. N. & Hay, R. *5569*, *5730* (31); *5999* (20).
Rose, J. N. & Painter, J. H. *6665* (31); *7025* (31a); *7026* (2a); *7910*, *7964* (31a).
Rothrock, J. T. — *733* (22); — (23).
Rousseau, J. *26646*, *30711* (23).
Rowlee, W. W. & Stork, H. E. *899* (24).
Rusby, H. H. —, *264* (22); *669* (45); *670* (59).
Rusby, H. H. & Pennell, F. W. *1269* (66).
Rydberg, P. A. *878*, *9619* (23).
St. John, H. *90687* (23a); *90688* (23).

Index to Species

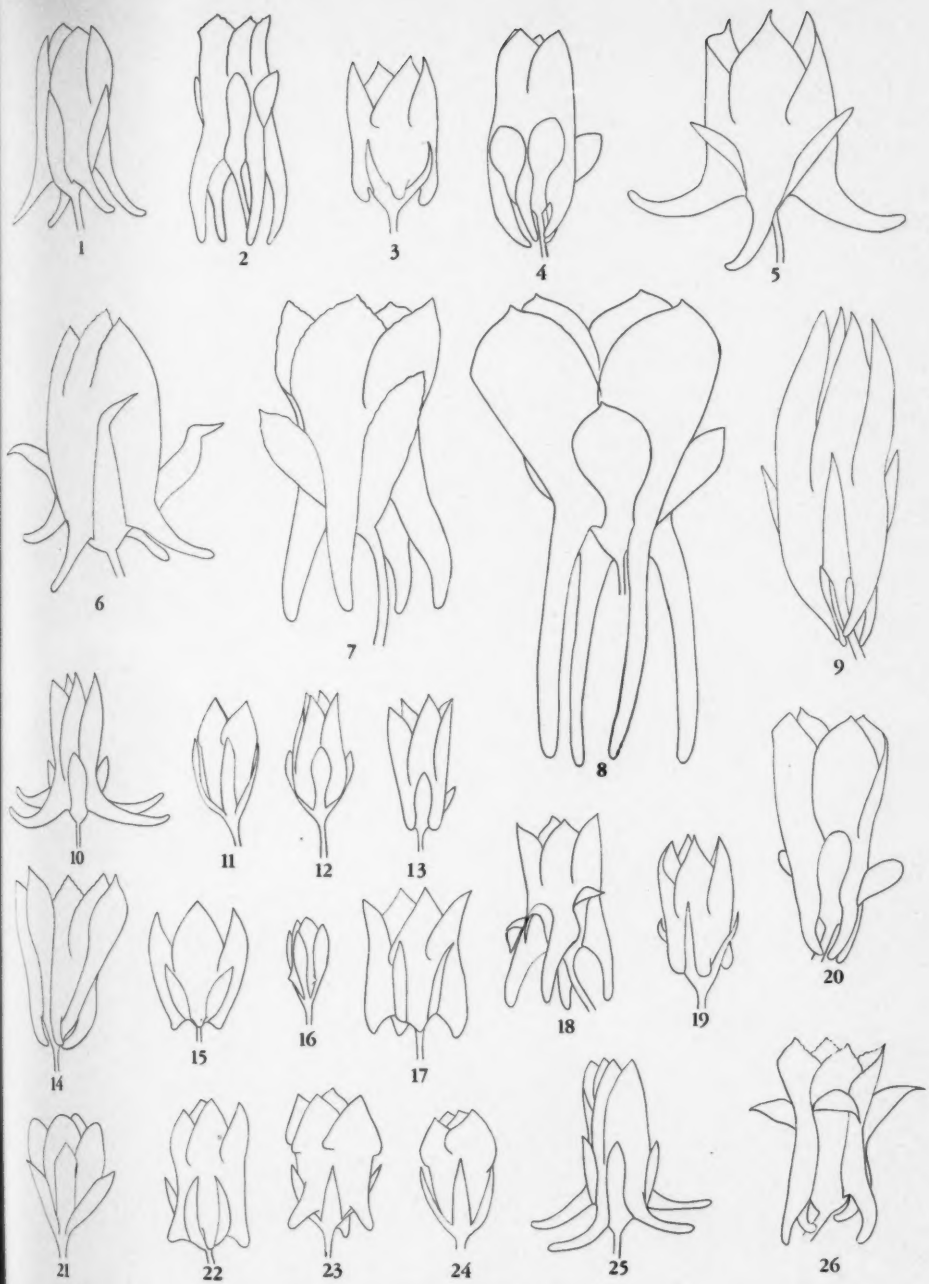
New genera, species, varieties, and combinations are printed in **bold face** type; synonyms in *italics;* and previously published names in ordinary type.

EXPLANATION OF PLATE

PLATE 8

Camera-lucida drawings of the flower of the following species of *Halenia*. ×2.

Fig. 1. *H. deflexa* (Sm.) Griseb. (spurred form).
Fig. 2. *H. decumbens* Benth.
Fig. 3. *H. brevicornis* (HBK.) Don var. *multiflora* (Benth.) Allen.
Fig. 4. *H. Conzattii* Greenm.
Fig. 5. *H. recurva* (Sm.) Allen.
Fig. 6. *H. rhyacophila* Allen.
Fig. 7. *H. Shannonii* Briq.
Fig. 8. *H. guatemalensis* Loesener.
Fig. 9. *H. Palmeri* Gray.
Fig. 10. *H. Pringlei* Rob. & Seat. (spurred form).
Fig. 11. *H. brevicornis* (HBK.) Don.
Fig. 12. *H. Pringlei* Rob. & Seat. (non-spurred form).
Fig. 13. *H. nudicaulis* Mart. & Gal.
Fig. 14. *H. platyphylla* Allen.
Fig. 15. *H. brevicornis* (HBK.) Don var. *latifolia* (Schl. & Cham.) Allen.
Fig. 16. *H. deflexa* (Sm.) Griseb. (non-spurred form).
Fig. 17. *H. brevicornis* (HBK.) Don var. *divergens* Allen.
Fig. 18. *H. Schiedeana* (Schl. & Cham.) Griseb.
Fig. 19. *H. brevicornis* (HBK.) Don var. *chihuahuensis* Allen.
Fig. 20. *H. plantaginea* (HBK.) Griseb.
Fig. 21. *H. alata* (Mart. & Gal.) Hemsl.
Fig. 22. *H. brevicornis* (HBK.) Don var. *Tuerckheimii* (Briq.) Allen.
Fig. 23. *H. brevicornis* (HBK.) Don var. *ovata* Allen.
Fig. 24. *H. brevicornis* (HBK.) Don var. *micranthella* (Briq.) Allen.
Fig. 25. *H. crassiuscula* Rob. & Seat.
Fig. 26. *H. caleoides* Allen.



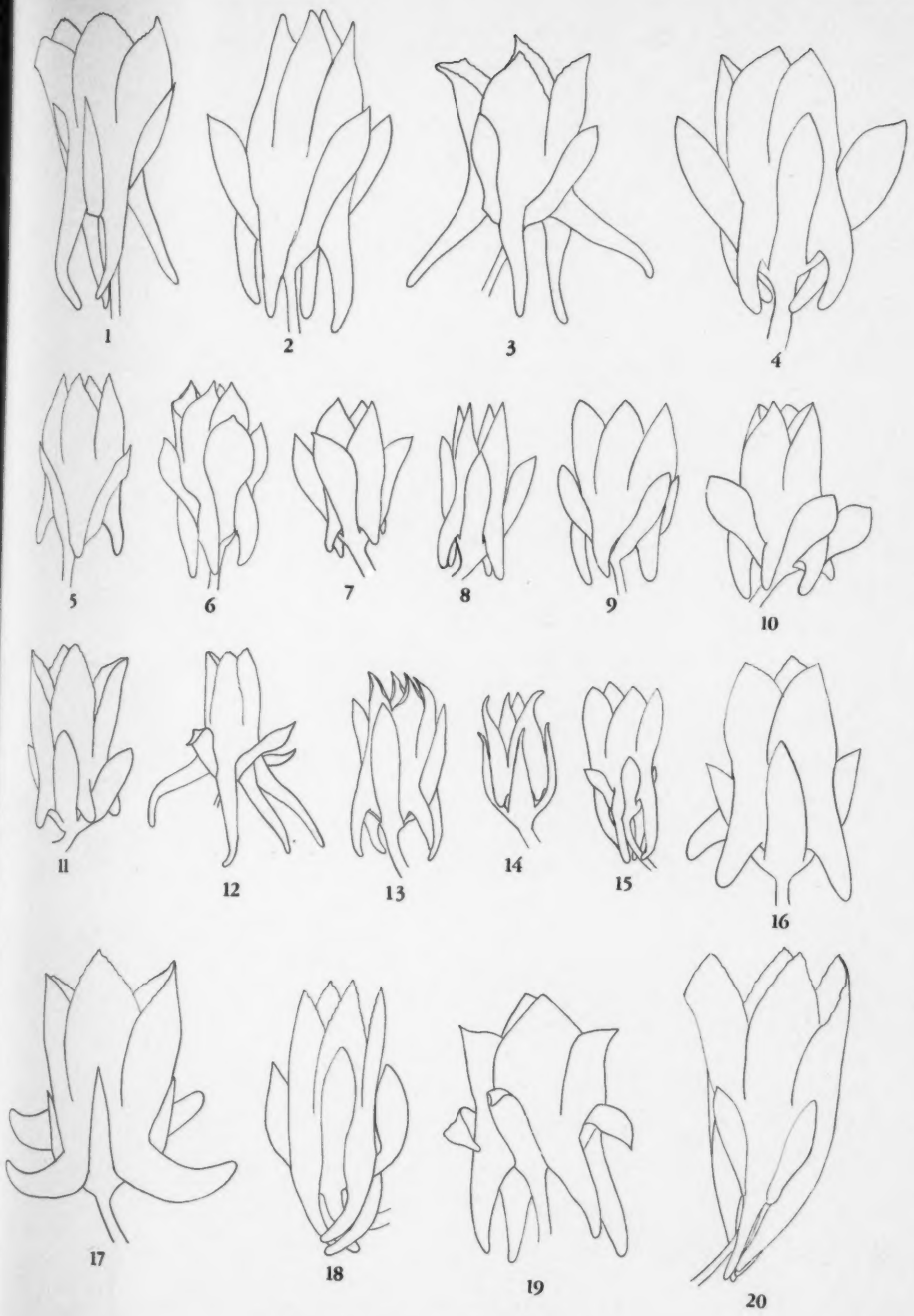
ALLEN—THE GENUS HALENIA

EXPLANATION OF PLATE

PLATE 9

Camera-lucida drawings of the flower of the following species of *Halenia*. × 2.

Fig. 1. *H. Purdieana* Wedd. var. *congesta* Allen.
Fig. 2. *H. Meyeri Johannis* Gilg.
Fig. 3. *H. Weddelliana* Gilg.
Fig. 4. *H. Killipii* Allen.
Fig. 5. *H. Stuebelii* Gilg.
Fig. 6. *H. gracilis* (HBK.) Don.
Fig. 7. *H. robusta* Gilg.
Fig. 8. *H. minima* Allen.
Fig. 9. *H. penduliflora* Gilg.
Fig. 10. *H. spatulata* Allen.
Fig. 11. *H. caespitosa* Gilg.
Fig. 12. *H. bifida* Rusby & Allen.
Fig. 13. *H. vincetoxicoides* Gilg.
Fig. 14. *H. pusilla* Gilg.
Fig. 15. *H. silenoides* Gilg.
Fig. 16. *H. Hoppii* Reimers.
Fig. 17. *H. asclepiadea* (HBK.) Don.
Fig. 18. *H. Weberbaueri* Allen.
Fig. 19. *H. Rusbyi* Gilg.
Fig. 20. *H. umbellata* (R. & P.) Gilg.



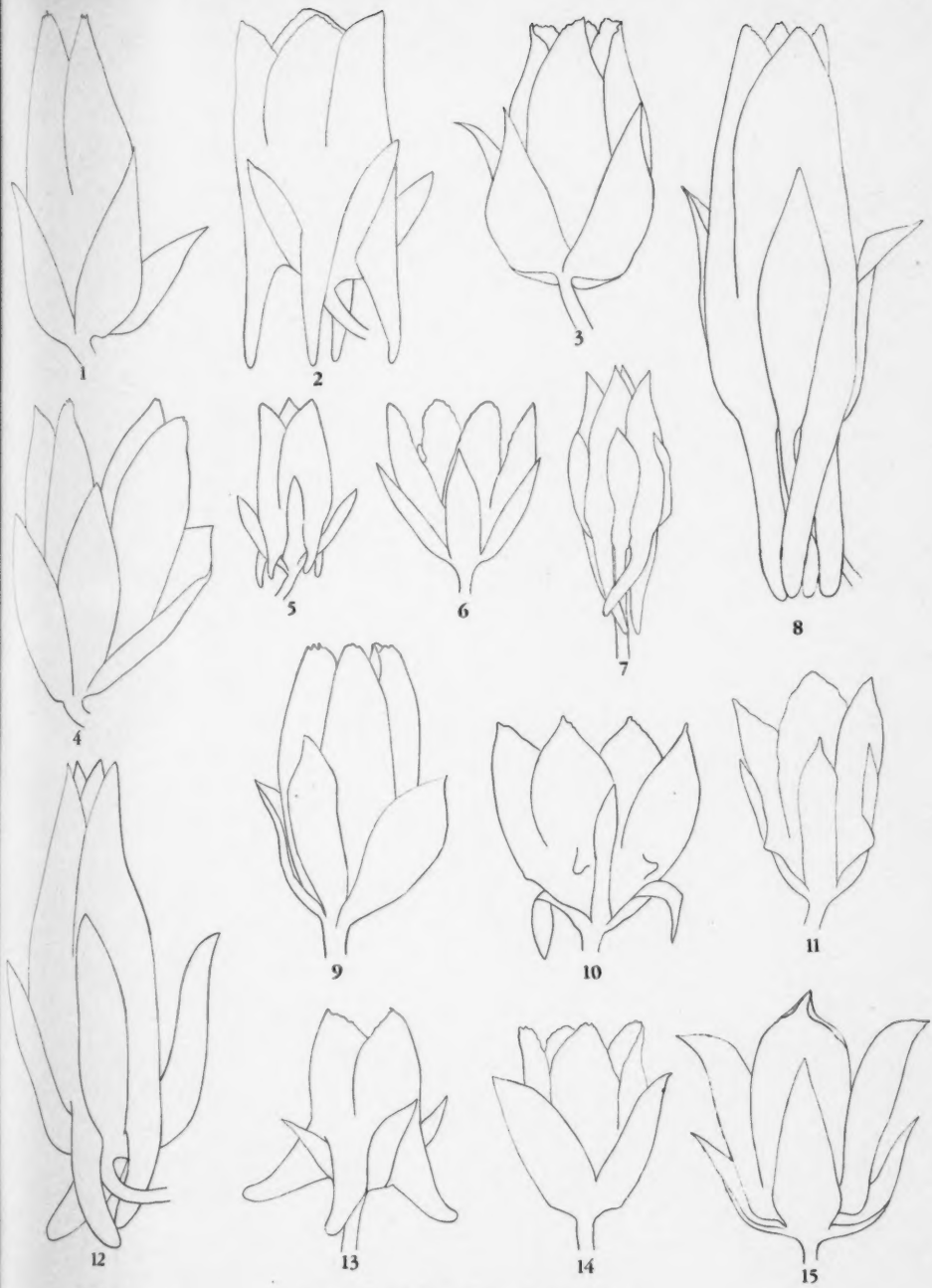
ALLEN—THE GENUS HALENIA

Explanation of Plate

PLATE 10

Camera-lucida drawings of the flower of the following species of *Halenia*. × 2.

Fig. 1. *H. verticillata* Gilg.
Fig. 2. *H. Purdieana* Wedd.
Fig. 3. *H. hygrophila* Gilg.
Fig. 4. *H. dasyantha* Gilg.
Fig. 5. *H. adpressa* Allen.
Fig. 6. *H. gentianoides* Wedd.
Fig. 7. *H. taruga gasso* Gilg.
Fig. 8. *H. elegans* Allen.
Fig. 9. *H. Tolimae* Gilg.
Fig. 10. *H. major* Wedd.
Fig. 11. *H. Karstenii* Gilg.
Fig. 12. *H. gigantea* Allen.
Fig. 13. *H. Kalbreyeri* Gilg.
Fig. 14. *H. inaequalis* Gilg.
Fig. 15. *H. parallela* Allen.



ALLEN—THE GENUS HALENIA

Explanation of Plate

PLATE 11

Camera-lucida drawings of the flower of the following species of *Halenia*. ×2.

Fig. 1. *H. subinvolucrata* Gilg.
Fig. 2. *H. viridis* (Griseb.) Gilg.
Fig. 3. *H. pulchella* Gilg.
Fig. 4. *H. bella* Gilg.
Fig. 5. *H. barbicaulis* Gilg.
Fig. 6. *H. elata* Wedd.
Fig. 7. *H. foliosa* Gilg.

1

2

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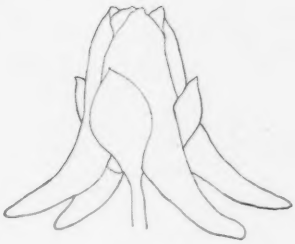

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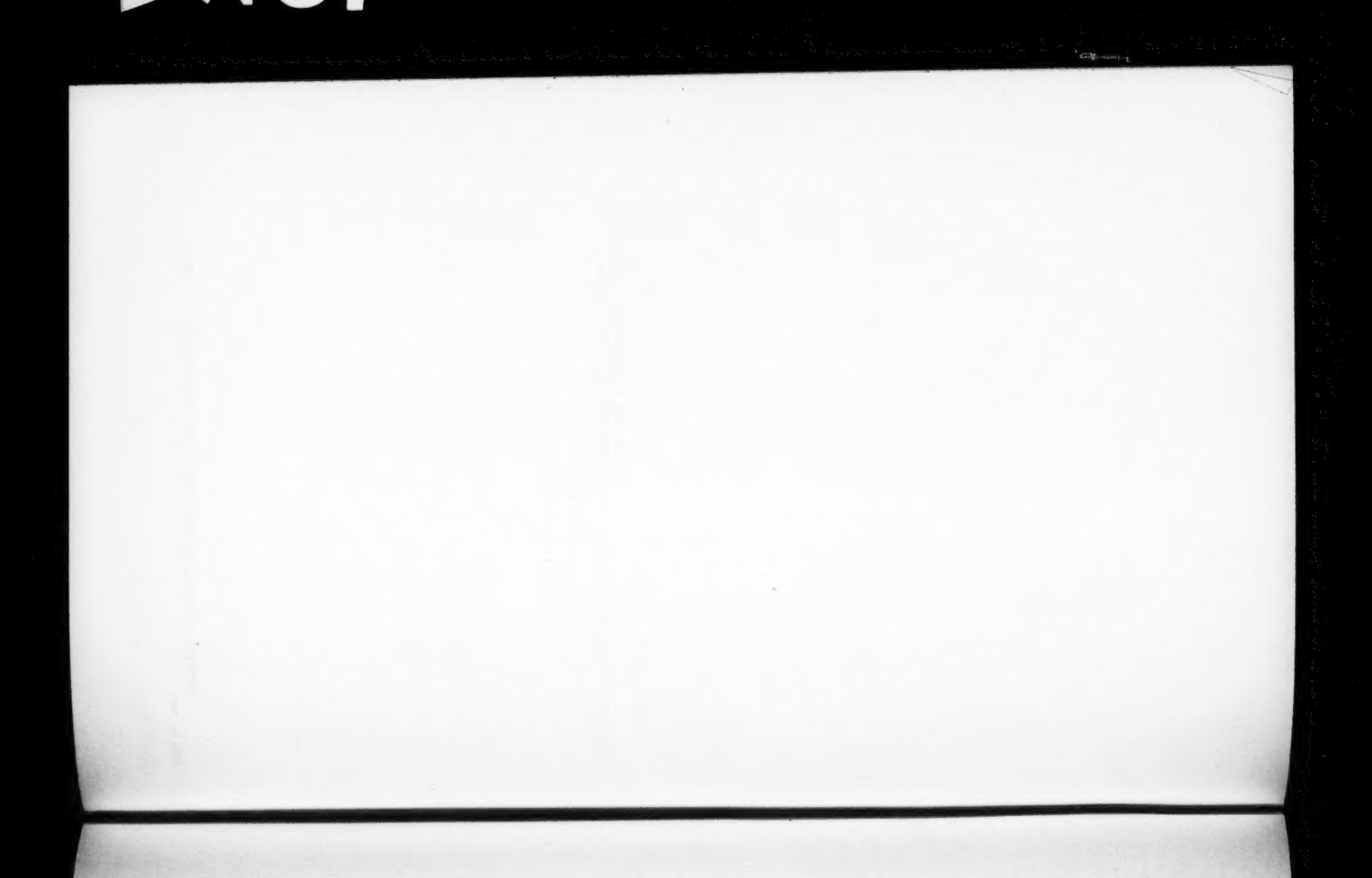
ALLEN—THE GENUS HALENIA

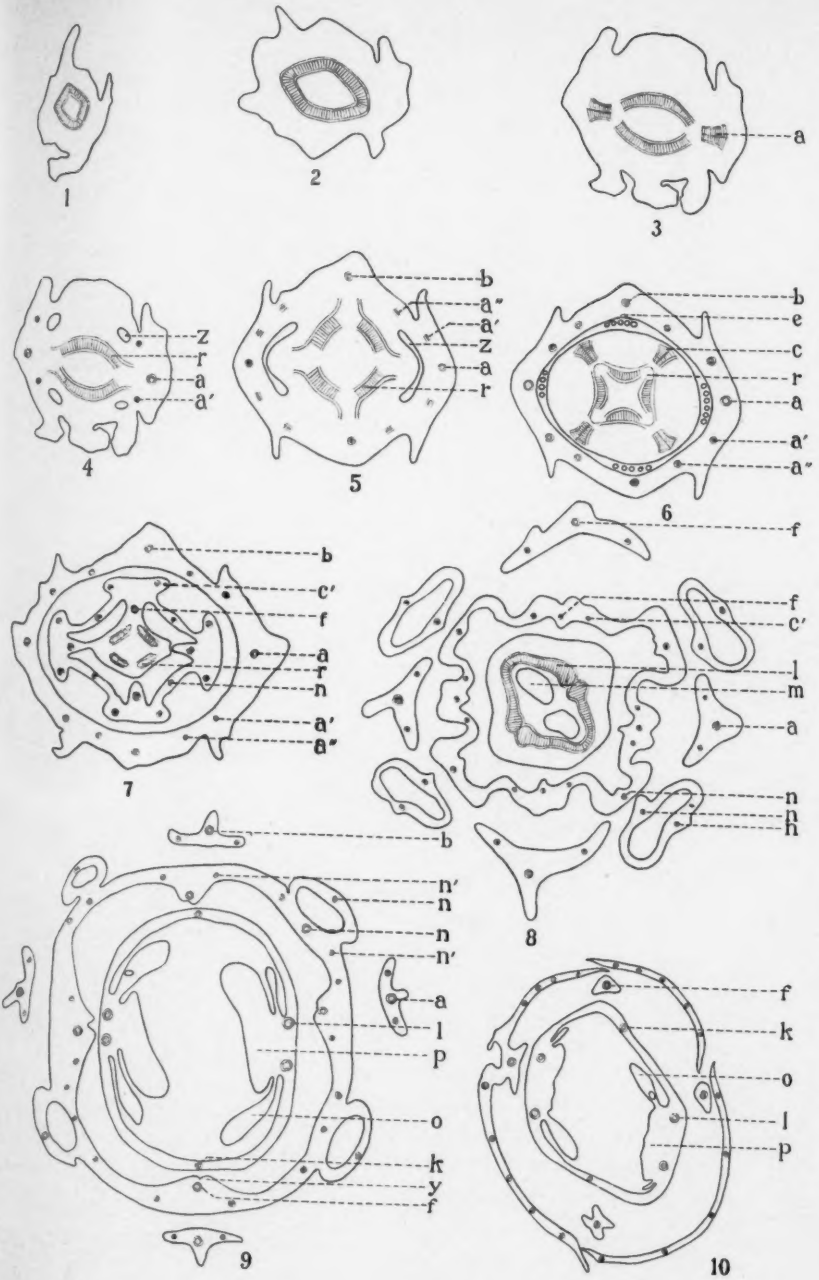


Explanation of Plate

PLATE 12

Diagrammatic serial transverse sections of the flower of *Halenia deflexa* (Sm.) Griseb. Explanation in the text.

del. A. Heinz



ALLEN—THE GENUS HALENIA

THE SENSITIVITY OF ORCHID SEEDLINGS TO NUTRITIONAL IONS

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I. Introduction

The germination and growth of orchid seedlings on artificial media have received considerable attention from plant physiologists. Almost invariably, however, their investigations have been concerned with the carbohydrate metabolism to the exclusion of the inorganic nutritional relationships. The purpose of the present paper is to report the results of a study on the sensitivity of germinating orchid seeds and young seedlings to different nutritional ions. The few available data on inorganic nutrition are scattered in the papers dealing primarily with other phases of orchid development on artificial media.

Burgeff ('09) pointed out that orchid seeds germinated more favorably when nitrogen was available as ammonium sulphate than as a nitrate salt. This fact led Knudson ('22) to modify Pfeffer's solution, and this is the solution frequently mentioned in orchid literature as "Knudson's Solution B." Clement ('24, '24a) has said that the nutrition of different species of *Odontoglossum* varies widely, but he did not elucidate the matter further. Ballion and Ballion ('24) made a similar statement, that in their work with *Cattleya*, *Miltonia*, and *Odontoglossum* the nutritional conditions varied according to the species, but here again no specific information was given. La Garde ('29) found that his solution L gave about 10 per cent better growth than did Knudson's solution B, and attributed this superiority to the slight increase of nitrogen and the large increase of potassium and phosphorus in his solution. Smith ('32) used Knudson's solution B, but found that doubling or trebling the amount of ammonium sulphate gave better growth and a deeper color to his seedlings.

In so far as we have been able to ascertain, the above brief review is complete as to published data concerning the inorganic nutrition of orchid seedlings.

II. METHODS

Livingston ('19) has clearly defined four possible criteria for the comparison of different nutrient solutions, as follows:—

(1) The volume-molecular proportion of any one salt.
(2) The osmotic proportion of any one salt.
(3) The total volume-molecular concentration.
(4) The total osmotic concentration.

As it is impossible to vary all the features of the composition of a series of solutions regularly at the same time, it is necessary to select arbitrarily one characteristic as the basis for comparison. Since it is probable that the solution must act upon plants primarily in an osmotic way, we have followed Livingston and many others in using the total osmotic concentration as the basis for comparative studies.

The triangular representation of a series of solutions of three components varying in any of the above ways was first introduced in physical chemistry by Schreinemakers ('93) and again by Bancroft ('02). Schreiner and Skinner ('10) first applied this method of investigating nutrition in their work on fertilizers. Since 1910 it has been used by various investigators to study the nutrition of several agriculturally important plants: wheat, by Shive ('15), McCall ('16), Livingston and Tottingham ('18), Van Alstine ('19), Meier and Halstead ('21), and by Tottingham and Rankin ('22); buckwheat, by Shive ('15, '17) and by Shive and Martin ('18, '18a); potato, by Johnston ('24) and by Martin and Shive ('20); celery, by Poole and Fant ('22); cranberry, by Addoms and Mounce ('31); peach seedlings, by Davidson ('28). After investigating the work of the above authors, it appeared to us that the triangular system of arranging a varying series of nutrient solutions provided the most satisfactory approach to the problem of the reaction of orchid seedlings to their inorganic substrate.

Seeds for the investigation were furnished from the greenhouses of the Missouri Botanical Garden through the courtesy of Dr. George T. Moore, the Director. Flowers of *Cattleya Trianae* Linden and Rchb. f. were pollinated November 17, 1930, and the largest and apparently the best pod was picked May 3, 1932, after a development period of almost eighteen months. It has

been the author's experience that in general the capsules first to mature furnish seeds of lower vitality than those maturing later; hence the one requiring the longest time to mature was used to supply seeds for the present work.

The nutrient solutions investigated were those of Type I and Type IV, as described by Livingston ('19). By the use of only three salts it is possible to arrange solutions containing the six major nutritional ions in six different combinations. Of these six possible combinations, only two will have all their ions added in unlike combinations. The compositions of the solutions used are given in tables I and II. In both types the total osmotic

TABLE I

TYPE I—KH_2PO_4, $Ca(NO_3)_2$, $MgSO_4$

Culture No.	Molecular proportion			Volume-molecular concentration		
	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
R1 S1	1	1	6	.0027	.0027	.0161
S2	1	2	5	.0025	.0049	.0123
S3	1	3	4	.0024	.0071	.0094
S4	1	4	3	.0022	.0089	.0067
S5	1	5	2	.0022	.0108	.0043
S6	1	6	1	.0020	.0122	.0020
R2 S1	2	1	5	.0053	.0027	.0132
S2	2	2	4	.0049	.0049	.0099
S3	2	3	3	.0047	.0071	.0071
S4	2	4	2	.0045	.0090	.0045
S5	2	5	1	.0041	.0104	.0021
R3 S1	3	1	4	.0076	.0025	.0101
S2	3	2	3	.0072	.0048	.0072
S3	3	3	2	.0068	.0068	.0045
S4	3	4	1	.0065	.0086	.0021
R4 S1	4	1	3	.0099	.0025	.0074
S2	4	2	2	.0094	.0047	.0047
S3	4	3	1	.0090	.0068	.0022
R5 S1	5	1	2	.0123	.0024	.0049
S2	5	2	1	.0118	.0047	.0023
R6 S1	6	1	1	.0145	.0024	.0024

TABLE II

TYPE IV—K_2SO_4, $Ca(H_2PO_4)_2$, $Mg(NO_3)_2$*

Culture no.	Molecular proportions			Volume-molecular proportions		
	K_2SO_4	$Ca(H_2PO_4)_2$*	$Mg(NO_3)_2$	K_2SO_4	$Ca(H_2PO_4)_2$	$Mg(NO_3)_2$
R1 S1	1	1	6	.0018	.0018	.0108
S2	1	2	5	.0018	.0036	.0092
S3	1	3	4	.0019	.0056	.0075
R2 S1	2	1	5	.0037	.0018	.0091
S2	2	2	4	.0037	.0037	.0074
S3	2	3	3	.0037	.0056	.0056
R3 S1	3	1	4	.0056	.0019	.0075
S2	3	2	3	.0056	.0037	.0056
S3	3	3	2	.0056	.0056	.0038
R4 S1	4	1	3	.0076	.0019	.0057
S2	4	2	2	.0077	.0039	.0039
S3	4	3	1	.0078	.0059	.0019
R5 S1	5	1	2	.0097	.0019	.0039
S2	5	2	1	.0098	.0039	.0019
R6 S1	6	1	1	.0116	.0019	.0019

* The solutions containing the highest proportion of $Ca(H_2PO_4)_2$ could not be prepared, because sterilization at the temperature and pH used caused precipitation.

concentration was one atmosphere. Mallinckrodt salts of highest reagent quality were used. One-hundred-cc. portions of the nutrient solutions were placed in 200-cc. Erlenmeyer flasks, 1.75 per cent of Merck's powdered "Reagent" agar added, and sterilized by autoclaving at 20 lbs. pressure for 20 minutes. Following the work of La Garde ('29), who found that maltose was the best source of carbohydrate, a 2 per cent concentration of this sugar was used in all cultures. A study of the hydrolysis of this sugar under our conditions of sterilization showed that about 10 per cent was hydrolyzed to glucose.

In addition to the six major nutrient ions there were added one-half part per million of manganese as manganese sulphate, and one-half part per million of boron as sodium borate. A ferric phosphate suspension was prepared as described by Living-

ston ('19) and 1 cc. added to each liter of nutrient solution. This gave ferric phosphate in the concentration of about 3 mgms. per liter.

Owing to the sensitivity of orchids to the acidity of the medium, each solution was so adjusted that the pH after sterilization was 4.8 to 5.0. Tables III and IV indicate the pH relationships before and after sterilization. The seeds were sterilized by shaking

TABLE III

THE ACIDITY RELATIONSHIPS OF TYPE I SOLUTIONS*

Sol. plus Fe, B, Mn, and 2% maltose	A	B	C
	pH as made up	pH adjusted before autoclaving	pH after 1.75% agar added and autoclaved
R1 S1	5.74	3.93	4.9
S2	5.10	3.91	5.0
S3	4.93	3.90	5.0
S4	4.90	3.90	5.0
S5	4.83	3.90	5.0
S6	5.08	3.90	5.1
R2 S1	4.86	3.93	4.8
S2	4.75	3.88	5.0
S3	4.73	3.93	4.9
S4	4.73	4.10	5.0
S5	4.83	4.10	5.0
R3 S1	5.26	4.22	5.0
S2	4.86	4.24	5.0
S3	4.83	4.20	5.0
S4	4.76	4.20	5.0
R4 S1	4.83	4.20	5.0
S2	4.81	4.22	5.0
S3	4.75	4.24	4.9
R5 S1	4.86	4.24	4.9
S2	4.83	4.22	4.9
R6 S1	4.80	4.29	4.9

* The pH determinations indicated in columns A and B were obtained by the quinhydrone electrode, while the results in Column C were obtained colorimetrically by the use of brom-cresol-green as an indicator.

TABLE IV

ACIDITY RELATIONSHIPS OF TYPE IV SOLUTIONS
DETERMINATIONS MADE AS INDICATED IN TABLE III

Sol. plus Fe, B, Mn, and 2% maltose	A	B	C
	pH as made up	pH adjusted before autoclaving	pH after 1.75% agar added and autoclaved
R1 S1	4.39	4.10	5.0
S2	3.71	4.18	4.9
S3	3.56	4.27	4.9
R2 S1	4.10	3.89	5.0
S2	3.67	4.20	4.9
S3	3.59	4.29	4.9
R3 S1	4.05	3.90	4.9
S2	3.73	4.22	5.0
S3	3.64	4.30	4.8
R4 S1	3.91	3.91	5.0
S2	3.69	4.25	4.9
S3	3.54	4.32	4.9
R5 S1	4.34	3.81	4.9
S2	3.78	4.15	5.0
R6 S1	4.27	3.90	5.0

20 minutes in a small vial of calcium hypochlorite solution prepared as described by Wilson ('15). They were then inoculated directly into the flasks of nutrient agar by a platinum wire inoculating needle. The flasks were incubated at 20–25° C. in a specially shaded greenhouse compartment. During the warmer summer days the greenhouse temperature could not be held below 30°, and on rare occasions 35°, but the short duration of these high temperatures apparently was without any harmful effect.

III. Results

Type I.—The growth period of these cultures extended from April 15 until November 12, 1932. At the end of this time, the

diameter of the seedlings was measured by a low-power microscope equipped with a calibrated eye-piece micrometer according to the method of Quednow ('30). The flasks had been very lightly inoculated so as to eliminate crowding of the growing seedlings. The figures in table v indicate the diameter in microns, each

TABLE V

GROWTH OF SEEDLINGS IN TYPE I SOLUTION. THE FIGURES REPRESENT DIAMETERS IN MICRONS

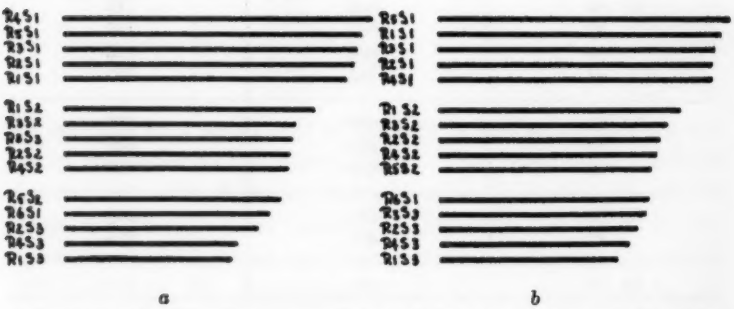
Solution	Series 1	Series 2
R1 S1	915	910
S2	1100	1130
S3	970	1020
S4	1015	1010
S5	925	940
S6	810	830
R2 S1	(Contaminated)	(Contaminated)
S2	925	980
S3	855	845
S4	600	740
S5	740	690
R3 S1	805	775
S2	660	740
S3	690	725
S4	585	445
R4 S1	860	690
S2	620	620
S3	620	670
R5 S1	635	640
S2	475	585
R6 S1	680	615

based on an average of 25 individuals. Figure 1 shows graphically the comparative development on the different media used. Figures 3 and 4 indicate the areas of the triangles corresponding to greatest, medium, and least growth. The circles are drawn to scale and represent comparatively the magnitude of the seedlings of the respective cultures.

Type IV.—The growth period of these cultures lasted from April 28 until November 20, 1932. Table VI presents the data for the growth on these solutions. As before, the diameter is indicated in microns and is the average of 25 determinations. Figure 2 shows graphically the comparative development.

a *b*

Fig. 1. *a:* diagrammatic representation of the relative diameters of seedlings germinated on Type I solution. Series 1; *b:* relative diameters of seedlings germinated on Type I solution. Series 2.



a *b*

Fig. 2. *a:* diagrammatic representation of the relative diameters of seedlings germinated on Type IV solution. Series 1; *b:* relative diameters of seedlings germinated on Type IV solution. Series 2.

Figures 5 and 6 show the areas of the triangles producing greatest, medium, and least growth, the circles being drawn as before to indicate the average diameters of the seedlings of the respective cultures.

TABLE VI

GROWTH OF SEEDLINGS IN TYPE IV SOLUTION. THE FIGURES REPRESENT DIAMETERS IN MICRONS

Solution	Series 1	Series 2
R1 S1	920	990
S2	825	825
S3	550	595
R2 S1	955	950
S2	740	740
S3	635	665
R3 S1	965	965
S2	765	770
S3	750	690
R4 S1	1010	950
S2	730	730
S3	570	630
R5 S1	975	1035
S2	715	715
R6 S1	675	705

IV. Discussion

Examination of figs. 3 and 4 shows perfect agreement between the duplicate series of Type I in the areas of greatest growth. These areas are characterized by having very low concentrations of KH_2PO_4. The five best cultures in row 1 have only one-eighth of the total osmotic concentration due to this salt. The ratios of calcium nitrate to magnesium sulphate are seen to vary between wide limits, .1667 to 2.500, with no significant effect on growth. The areas of medium and least growth do not show such perfect agreement in the duplicate series, but a comparison shows that the areas of medium growth correspond in general to those having the medium KH_2PO_4 concentration, and the areas of least growth correspond to those having the highest proportion of this salt. This relation is particularly clearly shown in fig. 4. From these data one may be led to the conclusion that germinating orchid seeds and young seedlings are comparatively sensitive to

varying concentrations of KH_2PO_4, but relatively insensitive to wide variations in $Ca(NO_3)_2$ and $MgSO_4$.

Since the ions were present as salts, it is impossible to determine which ion is responsible for the result. It is possible to add the six ions in but one other combination of three salts so that each anion will be linked with a different cation. This combination is represented by the Type-IV triangle. It is unfortunately impossible to prepare the complete Type-IV series because at the pH used (5.0) the solutions having the higher $Ca(H_2PO_4)_2$ concentrations precipitated on sterilization due to the decomposition of this compound.

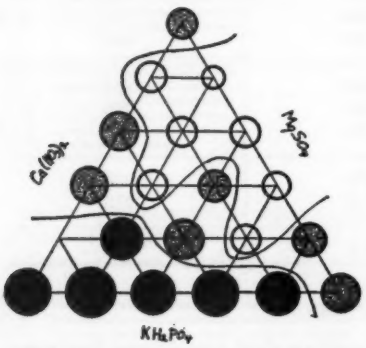


Fig. 3. Type I, series 1, showing areas of high, medium, and low yield. Culture R2 S1 omitted because of *Aspergillus* contamination.

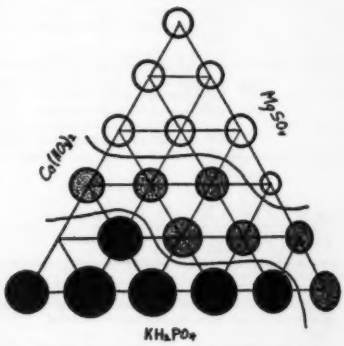


Fig. 4. Type I, series 2, showing areas of high, medium, and low yield. Culture R2 S1 omitted because of *Aspergillus* contamination.

Growth on the possible solutions of this type shows a remarkable result. The areas of greatest growth perfectly agree and are characterized by solutions having the minimal proportion of the total osmotic concentration due to $Ca(H_2PO_4)_2$. Again, the ratios of the other salts, K_2SO_4 to $Mg(NO_3)_2$ vary between wide limits, .1667 to 2.500, with very little effect on growth. The areas of medium growth correspond to those of medium concentration of this salt, and those of least growth correspond to the areas of high concentration of this salt.

This comparison of the growth on solutions of Type I with that on Type IV indicates that in both cases greatest growth was

associated with the lowest proportions of the phosphate salt, irrespective of which ion it accompanied, and that the relative proportions of all other ions were of comparatively little effect. The fact that growth was inversely proportional to the concentration of the $H_2PO_4^-$ ion seems to be related significantly to the results of Gregory ('28). This author studied the effect of the different ions on growth by an ingenious mathematical treatment of the results published previously by Johnston ('24) concerning the growth of potato plants in three-salt solutions. In studying duplicate series, Gregory found that in each the fraction of the total growth produced by the $H_2PO_4^-$ ion was a negative quantity.

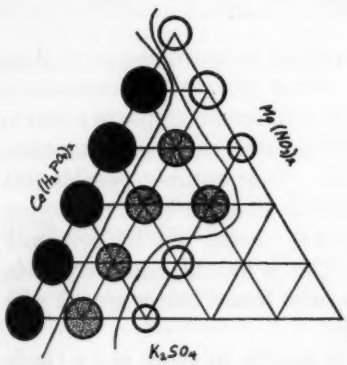


Fig. 5. Type IV, series 1, showing areas of high, medium, and low yield. The cultures of high concentration $Ca(H_2PO_4)_2$ omitted (see text).

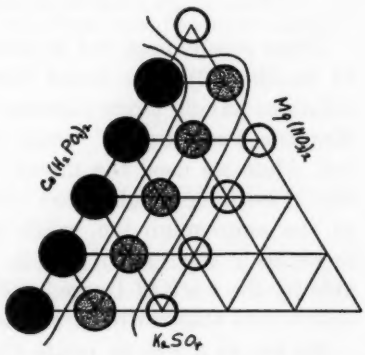


Fig. 6. Type IV, series 2, showing areas of high, medium, and low yield. The cultures of high concentration $Ca(H_2PO_4)_2$ omitted.

In general, he also found that the growth produced by other negative ions was much less than that produced by the positive ions.

If we indicate the concentration of each ion in a "molar" sense and compare the composition of the best solution of Type I and Type IV in table VII, an interesting analogy is apparent. Despite the great apparent variation in composition of these two solutions, we see that in both the concentrations of the negative ions are of the same order of magnitude, while those of the positive ions vary greatly. It seems therefore probable that growth was

being conditioned in both cases by the negative rather than the positive ions.

TABLE VII

CONCENTRATION OF IONS IN "MOLS" OF THE BEST SOLUTION OF TYPE I AND TYPE IV

	Type I	Type IV
$H_2PO_4^-$	.0025	.0038
NO_3^-	.0098	.0078
SO_4^{--}	.0123	.0097
K^+	.0025	.0194
Ca^{++}	.0049	.0019
Mg^{++}	.0123	.0039

These results need not be interpreted as contradictory to those of Smith ('32), who found that better growth was obtained in solutions having larger amounts of ammonium sulphate added to Knudson's solution B. Smith added nitrogen in the ammonium ion, while we used the nitrate ion. It is entirely possible that orchid seedlings might react favorably to an increase of nitrogen as the ammonium ion, while growth would not improve with increases in the form of nitrate. This is indeed made very probable by the work of Burgeff ('09), who found better growth with ammonium than with nitrate salts.

We are at a loss to relate these results to those of La Garde ('29) who states, in regard to superiority of his solution L over that of Knudson's solution B, as follows:—"The seedlings appeared darker in color and had progressed relatively further in development. This effect might be ascribed to the larger dose of phosphorus and potassium." Experiments now in progress, which will be reported later, show that La Garde's solution L is indeed a very favorable orchid medium, but it seems probable that we may not ascribe this quality to the increase of phosphorus and potassium *per se*.

This study further emphasizes the suggestion made by some authors that the Ca:Mg ratio is not of such importance as it was once thought. At least the limits of variation used in our experiments were not sufficiently great to produce any significant effect.

V. Summary

Seeds of *Cattleya Trianae* Linden and Rchb. f. were germinated on three-salt solutions of Type I and Type IV, with the following results:—

(1) The seedlings showed best development on media having low proportions of the total osmotic concentration due to the phosphate salt, irrespective of whether it was present as the potassium of the calcium compound.

(2) The proportion of all other ions within the limits used appeared to have relatively little effect on germination and growth.

(3) The negative ions appeared of greater importance in conditioning orchid seedling development than the positive ions.

(4) The best growth in Type I solutions was found in culture R1 S2 having the composition:—

KH_2PO_4	.0025 M
$Ca(NO_3)_2$	.0049 M
$MgSO_4$	.0123 M

(5) The best growth in Type IV solutions occurred in culture R5 S1 containing:—

K_2SO_4	.0097 M
$Ca(H_2PO_4)_2$	.0019 M
$Mg(NO_3)_2$	.0039 M

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